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ABSTRACT

This is a collection of papers presented at an annual conference of the College and University Systems Exchange (CAUSE). Thirty-one papers are reproduced in their entirety and 39 are presented as abstracts. Of the 31 complete papers, 12 have been individually abstracted for "Resources in Education" (RIE). The major topics of the conference were: (1) information systems in college and university management, (2) management of the information system resource, (3) technology and information systems. (DAG)

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The Managerial Revolution in Higher Education: The Role of Information Systems

Proceedings of the
1976 CAUSE National Conference

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December 1976

Orlando, Florida

Edited by
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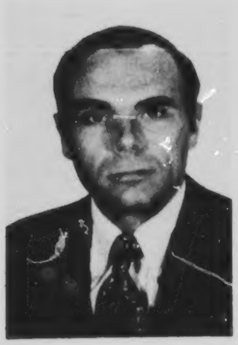

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The success of the CAUSE National Conference is due entirely to the contributions of people and supporting organizations. Although many people and organizations contributed time and effort to the planning and operation of the 1976 Conference, several deserve special note.

The Program Committee, with the CAUSE staff, spent many hours to produce an effective and smoothly run conference. Their efforts and the support of their institutions are gratefully acknowledged.

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The advance preparation for the conference and the publication of the proceedings require a great deal of experience and effort. Few organizations have an individual who handles these tasks with as much expertise as Mrs. Deborah Smith of the CAUSE staff.

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Finally, the financial support of the companies who sponsored presentations in the vendor track and those who sponsored the coffee breaks is especially appreciated. In addition, the contribution of the IBM Corporation to assist with the production of this publication is gratefully acknowledged.

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THE MANAGERIAL REVOLUTION IN HIGHER EDUCATION: THE ROLE OF INFORMATION SYSTEMS

Proceedings of the 1976 CAUSE National Conference

Orlando, Florida December 8-10, 1976

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THE MANAGERIAL REVOLUTION REVISITED

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The introduction of rationalized management in colleges and universities, consisting of computers, information systems, institutional research, systematic budgeting, and new forms of organization, was a logical response to the increasing complexity, pace, scale, and costs of higher education. In retrospect, however, it is evident that (1) the conditions in the universities were only symptomatic of larger forces at work in American society, and thus the new procedures could have only limited effect; (2) management designed to control rapid growth will not necessarily work in periods of stability or contraction; and (3) the "managerial revolution" has not yet addressed itself to fundamental issues of human values in American higher education.

Recall, if you will, the story of Rip Van Winkle. "On a fine autumnal day," recounted Washington Irving, "Rip had unconsciously scrambled to one of the highest parts of the Kaatskill Mountains." There he encountered "a company of odd-looking personages playing at nine-pins," who plied him with liquor from great flagons and soon lulled him into a long, mysterious sleep. When he awoke, he found that his entire world had changed. His own village "was altered; it was larger and more populous. There were rows of houses which he had never seen before, and those which had been his familiar haunts had disappeared. Strange names were over the doors--strange faces at the windows--everything was strange. His mind now misgave him; he began to doubt whether both he and the world around him were not bewitched." What is more, poor Rip found that "the very character of the people seemed changed. There was a busy, bustling, disputatious tone about it, instead of the accustomed phlegm and drowsy tranquility." So gradually, by a painful process of inquiry and realization, Rip understood that a great revolution--the American Revolution--had occurred during his long slumber. "It was some time before he could get into the regular track of gossip, or could be made to comprehend the strange events that had taken place during his torpor...."

There is an analogy to my own situation. Ten years ago, Francis Rourke and I tried to examine some of the beginnings of significant administrative change in American higher education. Having done that, I went into a decade of, well, not exactly slumber, but of benign neglect of the evolving events. Now, through this fortunate opportunity to reflect on the developments of these past years, I find myself in the situation of Rip Van Winkle. The administrative world has changed-- dramatically so, but not necessarily in in all the ways I had predicted. I find rows of offices which I had never seen before, strange names over the doors, and indeed a "bustling, disputatious tone," and I realize that it may well take me some time "to get into the regular track of gossip, or.... comprehend the strange events" that have taken place during my torpor.

But that, indeed, is my task, and I shall approach it in four brief stages: by taking stock of where we stood ten years ago with respect to the managerial revolution, by making some estimates of where we stand today, by reporting to you the judgments of some contemporary administrators about the value of modern managerial techniques, and then by drawing some conclusions of my own about the present status of the whole affair.

A decade ago, American colleges and universities were at a takeoff point in many areas of administrative modernization, but for the most part the innovations were tentative, their organizational status was precarious, and their benefits were uncertain. There was no doubt, however, that they were proceeding apace. Fueled by demands for increased efficiency, more data about university operations, and expanded capacities to absorb then-rising enrollments, universities had turned to a repertoire of new approaches.

Institutional research had already made solid inroads and was spreading throughout the country. Studies of all walks of university life were being carried out by specialized researchers. Their findings were being submitted to university decisionmakers, coordinating boards, and state and federal agencies, although not in every case were the fruits of their labors acted upon or even read.

The computer had found its way into most of the larger institutions, although many smaller schools still relied on traditional hand and machine processing. Computer offices occupied inconspicuous positions on the administrative organization charts. At this time, computers were used mainly to process routine data. They were expensive and relatively slow. They had not yet demonstrated significant savings in time, staff, or money. Comprehensive computer-based management information systems were little more than gleams in the eyes of some specialists. Only a handful of universities could claim to have anything that resembled a genuinely integrated system, and even some of these were ignored by top administrators.

The mid-sixties were the halcyon days of new budgeting techniques. Planning-programming-budgeting systems were in good favor in government circles, and universities scrambled to rationalize their budgeting procedures. It was a time of rapid increases in appropriations. Budget formulas provided a politically acceptable way to insure that a university would receive its fair share of financial support. The formulas themselves were usually hammered out in political bargaining sessions among university presidents and legislators, but once the fighting was over, the formulas had a neat, quantitative, almost scientific look about them which pleased everyone. Educators were happy with the thought that a rising tide raises all the boats, and had few occasions to worry about what might happen if the tide should start to go out.

More scientific forms of budgeting were frequently discussed but rarely used. PPBS looked appealing on paper but kept hitting persistent snags. What appeared so eminently rational to a young budget officer seemed menacing or silly to the president. Sometimes, in actual practice, universities employed two coexisting systems of budgeting. One was modernized, quantitative, analytical, systematic--and was used largely to give the impression to external constituents that the university was being highly efficient and scientific in allocating its resources. Less readily visible was a traditional budgeting system based on tough political realities. In the final analysis--at least in those days--it was pretty clear that the political system dominated the rationalized system, but that the situation could change over time.

If rationalized budgeting was designed principally for external consumption, quantitative space management was more of an internal matter. Ten years ago, space management was already well underway and was having substantial effects on the allocation of existing facilities and the planning of new space. Political problems were in evidence, to be sure, as departments and offices resisted the invasions of their empires, but space was so readily quantifiable, and pressures were strong to provide at least moderately equitable facilities. Thus administrators accepted space management readily--so readily, in fact, that they sometimes overlooked genuine differences among academic departments that should have been taken into account.

Administrative reorganization and modernized staffing were other large items on the agenda of universities a decade ago. Universities were taking a hard look at their internal organization to see if there were more efficient ways to carry out their activities. This need was intensified by the emergence of new activities and new kinds of people who were looking for stable roles in the administrative hierarchy. Where should we put the computer people? The institutional researchers? The budgeters? These were important questions of the day.

Just as there was concern for reorganization within institutions, great attention was being given to the creation or extension of multi-campus institutions and statewide systems. It was generally assumed that larger, more tightly integrated systems would produce rationality, efficiency, and economy. But persistent critics--many of them university presidents and legislators,--were fighting hard for institutional autonomy on the grounds that the big systems would add new, oppressive layers of bureaucracy without improving the quality of education or reducing its expense.

In short, the situation a decade ago was one of flux. Rourke and I thought that we saw certain likely trends and potentialities, but we were not entirely confident. We suggested that modernized management techniques had to be examined for their effects on the political power structure of universities as well as for their effects on economy and efficiency. Indeed, we noted that two quite different languages were often spoken in discussions of such techniques. The practioners themselves tended to think and speak--often rather naively, but sometimes with a certain cunning--in the language of the objective scientist, asserting that computers and information systems, for example, were purely neutral instruments of good management. The skeptics on campus tended to speak in the language of politics. These new devices, they said, are perhaps theoretically neutral, but practically they are capable of transforming the entire distribution of power within an institution.

Rourke and I cautioned against overzealous or premature application of new techniques of management. We argued, however, that they could have a salutary effect on higher education if they were applied with sensitivity to the distinctive features of academic life. We expressed concern about the operation of a kind of Gresham's law of quantification, in which an emphasis would be placed on those aspects of university operation which could be most easily measured, driving out other important but more elusive qualitative standards of educational endeavor. We commended the trend toward greater openness and candor in university management which seemed to accompany the introduction of modern data processing and institutional research. We expressed the hope that the computer could be used as an instrument of humanization of administration at the same time that we predicted, with more accuracy than I expected, that it appeared "inevitable that in the university of the future virtually every routine administrative contact with the student will be channeled through electronic data-processing equipment." Finally, we urged faculties to recognize that modern conditions required them to put their own houses in order by developing more systematic means of developing academic policy and making academic decisions. All of these processes taken together, we said, added up to an incipient revolution--a fundamental change in the character of administration in American higher education.

Now it is time to ask what has happened in the ensuing decade. In general, I want to suggest that we have indeed had a fundamental change sufficient to warrant the name of revolution, but that the nature of the change is not quite what it appeared to be in the middle sixties.

My first point is that there has been--to take some liberties with a term from socialist theory--uneven development of the revolution. It would appear that administrative modernization is not a package deal, in which one innovation inevitably brings others with it. Computerization, space management, and management information systems have proceeded with almost dazzling speed and comprehensiveness. Institutional research has expanded without producing dramatic change. Rationalized budgeting has remained largely where it was a decade ago, giving the impressive appearance of sophisticated objectivity, yet down deep retaining most of its traditional features. And administrative organization has made room for the innovations but has not changed very significantly. In coming to these brash generalizations, I have relied in part on the judgments of a number of administrators whom I consulted during the preparation of this paper. Let me quote from some of their remarks to give you the flavor of their views. (And here I must add one worthy statistic: university presidents and directors of institutional research reply to letters more promptly and extensively than do financial vice presidents, budget officers, and directors of computer centers.)

My leading question was: have new management techniques made substantial changes in the way administrative decisions are made in your institution? The response was, in effect, "not much in the ends but quite a bit in the means." A director of institutional research put it succinctly: "we still rely primarily on the collective wisdom of those most experienced in the subject of the decision. However the degree of refinement and precision of thought which some of our deans and vice presidents now bring to important decisions is significantly greater than it was ten years ago." He added the tantalizing suggestion that there is a generation gap at work when he said "the more recently appointed deans and vice presidents rely more heavily upon data and analysis than those who have been around a long time." An academic vice president at an institution known for its avant garde techniques concluded that "new management techniques have allowed us to maintain a reasonable decision-making posture during this period of significant growth" and "have aided...in attempting to respond to the ever-increasing mandates of the state and federal government." But he suggested further that the techniques had not penetrated far up in the administrative echelons. "Top level administration" he said, "has not received the optimal benefits of these techniques as the resources have been channeled into operating management." I take that to mean that the middle bureaucracy has grown and has taken charge of the techniques but the principal administrators are still isolated from them.

The presidents are somewhat less complimentary. The chancellor of a major university concluded that "the 'revolution' in the management of higher education has changed the language of discussion but not the essential core of the decision-making process. Decisions now take place at two levels. Analysts of the campus talk with those of the system who talk with those of the coordinating board who talk with those in the bureau of the budget in the state capitol. They trade materials and reports and generally don't do much harm. On the other hand, the real decisions get made when the governor and the legislative leaders make determinations having to do with bottom line numbers of how much will be given to various segments making claims upon the state's resources." For example, he noted, "analysis might show that one part of the higher education system could be 'efficiently and effectively' closed down, but the political realities are that it can't be done. In fact, even within a campus the alteration in flow of resources is determined by 'political factors,' only slightly influenced by the developments that we called 'the managerial revolution'."

Another president of a sizeable state college told me that "relatively few of the newer management techniques have resulted in substantial changes in our decision making process....However, since new techniques and machines have the potential for providing data to assist in administrative decision making, they can enable us to make more intelligent projections, and can save us time that might be used in working with people and ideas...." He added that his institution had even "dallied from time to time with some things developed by WICHE."

A more abrupt judgment came from the feisty head of a large branch campus of a state university: "Administrative decisions are made as they always have been made," he contended, "largely on the basis of seat-of-the-pants responses."

While there may be some reservation about the effects of new techniques for budgeting and the way that power is arranged in the university, there is another consistent theme that emerged from my informal explorations. It is that computers have been lifesavers. "By far the most important development," said one chancellor, "has been the application of the computer to the development of systems to handle the paper flow and to permit us to do a more effective job of running registration, the business office, the library, and so on." A major university president concluded that the computer and the use of models were the most significant changes in university management. "The computer," he said, "enables us to do 'more with less'. We are powerful in new ways," he adds, "but also vulnerable in new ways." He did not elaborate on his sense of vulnerability, but I suspect that it was along the same lines of one administrator who said, "The managerial revolution gets both praised and blamed for results for which it is not responsible. Many faculty members believe that the reason why resources are more scarce now than in the past is because the 'business managers' have taken charge."

Another issue that concerned us a decade ago was whether managerial innovations designed in a period of enormous expansion would function quite differently in a time of contraction or a steady state. I asked my respondents that question, and got rather mixed replies. They felt that it was easier to get agreement on politically delicate matters during periods of affluence--for example, to agree on budget formulas or the introduction of new procedures. They believe it was possible to paper over misallocations and mistakes as long as the pie was getting larger. But when times are tight, as one administrator noted, the "reallocations become painfully apparent to everyone. A shift in priorities has to be much more carefully examined, documented and defended. In a word," he said, "decisions must be better informed decisions....In a period of prosperity even the naive and uninformed administrator may well be the beneficiary of unexpected events; in a period of austerity he is more likely to be the victim." I would put it another way: administrators, faculty, and politicians go along with modern management when it gives them comparative advantages in the competition for scarce resources. When those advantages are threatened, there is a good chance that they will abandon the system and revert to conventional managerial warfare.

A third question that interested us a decade ago and continues to interest me today is whether modern managerial techniques have made university administration more personal or have created a more dehumanized atmosphere. Again, the jury is divided. Most of the administrators that I have surveyed seem agreed that there is less time for personal, face-to-face relationships with their colleagues and with students, but they are not inclined to put the blame on computers or management information systems. On the contrary, they seem to feel that these techniques have, on the whole, been an asset in the struggle to maintain human contact.

This conclusion seems to be confirmed by the experience at my own institution, which in recent years has developed a complicated computer registration system to handle a nine-module course program in which courses of differing length and format run simultaneously. The system operates like a United Airlines reservation system. Within strict upper limits on class size, students register for a full year of courses but are free to drop and add future courses at any time during the year. For a student body of only 1800 students, our registrar reports that there are around 20,000 drop-add transactions during the year. It is incredible, but it works. The winning combination is a smart registrar, a pleasant registration staff, a sensitive computer shop, and Smedley, the tireless computer who lives in the basement. Registration has even been made something of a game involving betting points on courses to get what they want. Our students actually seem to enjoy the process.

To recapitulate my analysis so far: development has been uneven and results have been mixed; administrative modernization is not a complete package. But there is something more to be said. Ten years ago, it seems to me that none of us was sufficiently aware of the way in which American higher education and its management systems were shaped and limited by larger forces at work in our society. To be sure, most of us who thought about these things usually said something about how there had been a great increase in enrollments in higher education, how the proliferation of institutions created new demands for coordination and rational management, how the knowledge explosion added to the complexity of modern higher education--the litany is long and familiar. But I, for one, had not seen the full significance of those factors a decade ago.

The real revolution in management is not measured by the techniques it employs, but rather by the fact that management as a whole has become deeply implicated in a social order whose main characteristics are vast size, great complexity, and what social theorists call "the industrial mode of production."

The statistics about the size of the American educational effort are too familiar to repeat here. What we must remember, however, is that no universities in the Middle Ages exceeded 800 students, and frequently dropped below that number when the plague or political conflict thinned their ranks. It was not until 1914 that a university in the whole Western world exceeded 5000 students. Now we work with systems that are literally measured in tens and hundreds of thousands.

Along with these changes in size have come massive differentiations of structures. Faculty departments of large universities are legion. Administrations are divided into offices that are so specialized and so technical that one office literally does not know what another is doing, even in those institutions which pride themselves in face-to-face relationships and even, heaven help us, in those which have integrated management information systems. In the light of such enormous changes in scale and specialization, we must, I believe, admit that the structures of the modern university and the society in which it resides are qualitatively different from their ancestors. That is something we have missed in many of our discussions of the managerial revolution.

In this regard, Rourke and I did not fully appreciate the significance of national organizations of university administrators in furthering managerial innovation. At that time, most of the organizations were the traditional alphabet soup of budget, registration, computer, space, and institutional research people, mostly exchanging information and having a good time at national conventions. Since that time, the appearance of NCHEMS and CAUSE represent an important development in the evolution of university management because they provide new dimensions of services, programs, and norms of operation on a national scale. The change, however, is not necessarily an unqualified plus for higher education. NCHEMS, for example, has had some worthy ideas, but it has become an institution with vested interests in the success of its programs. As one influential university president put it, "NCHEMS stands in the vanguard of those who would build models. Bluntly, most 'don't fly'." Having served on one of the NCHEMS numerous advisory committees during its formative years, I can testify personally to the fact that there were--and are--many highly competent and dedicated individuals in such groups. Yet, it must be said that some national organizations tend to develop a momentum and life of their own which may have little to do with the central needs and purposes of higher learning. So far, CAUSE seems to be a happy exception. Built on the membership and administrative practices of individual institutions and a lean central office which serves as a clearing house of ideas and data, CAUSE provides a much-needed communication network without adding to the weight of a national administrative bureaucracy in higher education.

So far, I have spoken of size and complexity. The other factor is the industrial mode of production. When Adam Smith published The Wealth of Nations in 1776, he saw that industrialization involved much more than the development of machines as substitutes for human labor. He believed that an enterprise--indeed a whole society--built on the principles of specialization of work and interdependency through a system of free exchange would be substantially more productive than a society of localized, self-sufficient individuals. He was essentially correct. Specialization, rationalized organization, and interdependency combined with machines and new energy sources to transform western civilization. The transformation was so astonishingly complete and so powerful that it has affected not only the basic productive sector but every other form of human organization. Consider college sports, to take an amusing example. Ask a football player from the institutions represented here to describe himself. He is likely to say "I am a strong side linebacker," or "I play defensive end on probable pass situations between the thirty yard lines." The chilling fact is that such systems work. These giant, specialized, professionalized organizations--one could almost call them organisms because they are so tightly interdependent--now dominate our society. Lewis Thomas, in his fine little book The Lives of a Cell, would have us think of the whole earth as a kind of living organism. It is tempting to add, with more pride than accuracy, that the university functions as a lobe of the organism's brain. In one respect, that is a noble and edifying metaphor. In another respect, it is a frightening thought, because it suggests that the interdependency has become so great and so complete that malfunctions in one part of the organism--let us say in the production of wheat crops in the American midlands--could bring calamity to the entire society and with it to the whole system of higher education.

That is what I mean when I say we are implicated. As individuals and as institutions, we are committed to maintain a system that extends far beyond the campus. We are proud of our abilities to manage large and complex institutions, but there may be some truth in the idea that the institutions are actually managing us.

Nowhere is our implication better revealed than in the present confusion over the leveling off or shrinkage of enrollments and funds. The response of many institutions is to become more and more involved in the industrial mode of production. The pattern is becoming familiar. Universities hire professional fund-raisers, undertake national and regional advertising campaigns, change their curriculum to attract new kinds of students, and start cutting costs in all areas of university operation. A Chicago Tribune correspondent, Joan Beck, argued in a recent column that these measures were not sufficient. Administrators would now have to attack the academic heartland. "Faculty," she said, "will have to be more productive....Most teachers now work only 36 weeks a year. Many have teaching schedules that leave much time for other endeavors....Demands that teachers do research and publish will have to be re-evaluated....Better methods of cost accounting will have to be used in colleges....(and) tenure will have to be phased out." These are not radical proposals, and indeed some of them deserve careful consideration. What is most striking, however, is that they reflect progressive industrialization of the university enterprise. The blending of the university and other institutions of society is pervasive. This is not so much to say that the university has become a factory. That is an oft-repeated error. More accurately we should say that educational institutions, businesses, industries, government agencies, and even research and philanthropic organizations are converging on the industrial mode as the central characteristic of their organizational style. While a state university may apply productivity measures to its faculty, Xerox and IBM have many plants that look essentially like college campuses and their employees operate much in the same way that faculty members do. This blending has occurred so gradually, so unintentionally, that we can scarcely say it was a matter of deliberate educational policy. It just happened, and here we are, and that may be the real revolutionary event.

This brings me to my final and perhaps readily anticipated remark. University administrators need to reexamine the fundamental purposes of their institutions if higher education is to survive and prosper. For I have come to agree with Robert Nisbet, in his trenchant analysis in The Twilight of Authority, that "the university and college are fast becoming expendable in the minds of a growing proportion of the Western population." The reason, he argues persuasively, is that there has been a "transformation of the university from a community founded upon the academic dogma that knowledge is good in its own right and must be the core of any academic community to an organization that bears less and less resemblance to community of any kind and more and more to factory, office, and marketplace. Institutions thrive when their functions seem distinctive and important; and they undergo decline and death when their functions have come to seem more or less indistinguishable from those performed by other institutions."

In this spirit, I suggest that it is not enough to appraise the managerial revolution in higher education purely in terms of the efficiency it has brought to colleges and universities. Nor is it sufficient to comment on the effects of such management on the power structure of higher education. What must be added is a serious analysis of the ends of the university as a human community, and the place of that institution in a society deeply committed to giant organization and sometimes dangerous interdependency. To put my own biases on the line, I believe that administrative procedures should enhance the qualities of educational community, institutional autonomy, and creativity for students and professors. Those which uncritically foster increased centralization, costly and needless standardization of educational activity, and a proliferation of administrative bureaucracy, are merely hastening the day when American colleges and universities will lose the remnants of their distinctive character and function in a free society.

THE ROLE OF THE MINICOMPUTER IN ADMINISTRATIVE DATA PROCESSING

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We all live in a world of constant change. This view is particularly evident to those of us working in the computer business. One can recognize the tremendous impact of the computer in today's society; and then when you look at it in a historical perspective, the computer industry is only an infant.

It was only some 30 years ago that the first working computer, called the ENIAC, was in service at the Aberdeen Proving Ground in Maryland. This machine, developed by Professors Eckert and Mauchly from the University of Pennsylvania, was absolutely amazing in terms of its performance. It completely eclipsed all previous methods of manual or automatic calculations. Today, only one and a half generations later, entire rooms of computer equipment can be out performed by just a handful of highspeed, bi-polar microprocessor chips.

Harris announced a system last June at the 1976 National Computer Conference in New York City which has the effective computing power of upwards of a million times more than the original ENIAC when one considers all the factors that go into effective work. The actual computer in this system is mounted on only one board and contains many large-scale arrays including six of these microprocessors. Certainly a dramatic example of change.

In the early 1960's, Dr. Elmer Engstrom, President of RCA, made the following comment in a talk he presented: "The majority of the scientists and engineers produced by the human race in all of its long history are alive and at work today." The significance of that statement is even further enhanced when one recognizes that these scientists and engineers were also using the most powerful tools ever devised by man including large-scale digital computers. It was only a few years after these remarks were made that we began to see the emergence of a new approach to computing which was quickly dubbed the "minicomputer."

The first of this new breed was the PDP8. Introduced in 1965, it became an immediate commerical success and was the cornerstone for one of the largest computer companies today. This machine sold for only $18,000 including 4K or memory which astounded those of us working within the large-scale computer area.

Since that time, we have seen expansion of minicomputers in both directions. Today, we have the smallest of "microcomputers" up to the largest of "super" minicomputers. The spectrum has become so broad and the applications so diverse that it is almost meaningless to use the term minicomputer. However, there is a generally agreed upon definition of the classes or categories of minicomputers. I will discuss them here, briefly, in order to reduce or eliminate any misunderstanding.

Class I

These minicomputers are really a microprocessor on a board or in a box. The usage of them are growing very rapidly, and it is my belief that they will permeate almost every sector of our lives. In the near future we will see them in home appliances, home entertainment, automobiles, etc. It is a powerful new tool, and we are just learning how to use it effectively.

Class II

These minicomputers are those with word lengths of less than 16-bits, limited computer power, and limited memory capability. These are the older machines such as the PDP8 mentioned previously.

Class III

These minicomputers are the 16-bit machines which, even today, make up the majority of the market. They have been the backbone of the astounding growth of this industry. Found mainly in industrial process control applications, they are scattered throughout the research and development laboratories around the world.

Class IV

These minicomputers are machines with word lengths of 16-, 24- and 32-bits, with extensive memory capability, many hardware options, and significant software offerings. It is the Class IV minicomputer systems that are the major ones in administrative data processing.

One of the key reasons that we may now consider Class IV minicomputers for Administrative Data Processing has been the fantastic increase in performance per dollar spent. Over the years, this price/performance ratio has been increasing in an exponential fashion.

It is simply not easy to measure the effectiveness ofcomputer power in relationship to any other purchase. For example, if you want to evaluate a new automobile you can go to the showroom, determine the number of cylinders in the engine, its horsepower, its gasoline mileage, whether it's a two-door or four-door vehicle and then you can drive it and make your judgement regarding comfort, handling ability, etc.

When you set out to measure the effectiveness of a computer system, the purchasing decision becomes a more complex problem.

At the Harris Computer Systems, we have done extensive "modeling" and we believe we understand thoroughly the many complex and interacting variables that relate to effective computer power. We track and plot some 26 categories and each of these are broken into as many as ten subcategories. With weighting techniques and regression analysis, we have been able to closely describe the capabilities of computer systems in the marketplace over the last 20 years. With the increase projected in computer power, we feel we can accurately predict what those of us in the industry will be able to provide over the next four or five years.

With this background and recognizing that the rate of change in the computer business is still increasing let's look at some of the features of the Class IV minicomputers that are of interest to those in administrative data processing. First, these machine possess very strong compute power. You will find they contain state-of-the-art technology. The liberal use of large-scale, integrated circuits and microprocessors contributes to this power. There are many hardware and hardware/software options available which can further increase the effective power in doing certain kinds of specialized work. Harris, for example, offers a very powerful floating point, hardware Scientific Arithmetic Unit as an option. For those people with heavy FORTRAN "number crunching" tasks, this option gives tremendous increase in effective power.

Another feature is the availability of large on-line memories and even some virtual memory operating systems. At Harris, for example, we can put as much as 756,000 bytes of on-line memory coupled with our virtual memory operating system called VULCAN. VULCAN, which is a true virtual memory operating system operating through paging hardware in the mainframe, gives the user essentially unlimited memory capabilities with very efficient paging and control. Until just a few short years ago, this kind of capability was available only on the larger machines in what I will refer to as the IBM market.

A third feature is the file handling capability of Class IV minicomputers and, in fact, some computer manufacturers, such as Harris offer complete data base management systems. With large, on-line memories and powerful operating systems, it is a natural to add effective file-handling capabilities. For this requirement, Harris selected CINCOM's highly successful TOTAL system which enables users to operate large data base systems using standard COBOL while operating under a true virtual memory operating system

This, in turn, leads us to another feature — the ease of conversion. Just a few years ago, the minicomputer world was full of non-standard software. The "home grown" specials were the ones that were featured. When you recognize that the main thrust of minicomputers would be for laboratories where little software is required, this evolution was a very natural one. Today, however, most of the computer manufacturers in the Class IV category offer standard languages.

Harris supports seven languages under its operating system, including 1974 ANSI standard COBOL, as well as the latest approved version of FORTRAN and many others. Use of these standard languages makes conversion of customers software from one machine to another easier, faster, and more efficient. In fact, we have found that if your programs are written in the IBM COBOL, which is ANSI 1971, this conversion is really very easy.

Finally, a main feature in Class IV minicomputers is the greatly improved price/performance ratio available on most of these systems, especially when compared to traditional systems used for administrative data processing. With budgets tight and additional money scarce, the prudent data processing manager must consider these factors in looking ahead at the problems he must solve in his business.

With all these wonderful features, perhaps you are thinking you should throw out everything you have and replace it all with these Class IV minicomputers! However, we all honestly know that there is no such thing as a "free lunch," and indeed, any decision should be made carefully by considering all the known factors involved. There are some major concerns in using minicomputers in administrative data processing, and they should be examined in light of your own particular situation.

First, let's talk about software as a major concern in the computer buying process. As I said earlier, a few years ago only very minimal software was available on any minicomputer. Today, extremely powerful software is available from a few ofcomputer manufacturers. This alone should cause a serious computer buyer to be concerned about the maturity of the software. For example, Harris has had its virtual operating system in the field for well over three years. It takes this kind of time and care and attention to achieve the necessary degree of maturity and effectiveness.

Additionally, the traditional computer suppliers to the administrative data processing market bring with them a large array of applications packages. Conversely, the minicomputer manufacturers offer very little. I do realize with the active programs of CAUSE, that your organization has available a very large and active exchange program or application packages.

Another major concern in the area of software selection is that of security. A few years ago when the minicomputer was used in a laboratory, security was not much of a problem. The use of the machine was usually controlled by a small group, and the computer area could be locked at night eliminating unauthorized access to either equipment or data.

In the kind of processing centers that we are talking about today, this is not always the case, and one must seriously be concerned about security. As one of my university friends puts it, you must include the "diabolical sophomore factor" in your thinking. At Harris our system software designers recognize these potential problems, and they provided elaborate features to assist users in establishing security of the files, access to only selected files, and dynamic assignments of user priorities.

Another area of concern is using Class IV minicomputers for administrative data processing is that of support. Generally, minicomputer manufacturers do not provide the broad array of literature offered by the traditional suppliers to this marketplace. Literature is generally complete, but written with a high technical content as one would expect from companies who only a few years ago dealt just with engineers.

Along with literature, one should examine the availability of training and service to match the particular requirements. At Harris we offer service going all the way from a short training course and a phone number to a full time on-site personnel. We feel that service should be tailored to the needs of the customer. Finally, in this area of support, Users Groups are just beginning to be established. Membership is a User Group may not be a serious requirement in your own center particularly since you belong to the CAUSE organization, but it is a concern and should be considered.

Well, that's where we are today when one considers the capability of Class IV minicomputers to serve the administrative data processing area. What are the trends? I believe there are some very exciting things coming down the road and I wish to mention just a few of them.

We have been hearing the buzz words of networking and resource sharing for a number of years now. This is another of those ideas whose time has arrived. Some networking capability is already offered by some of the computer manufacturers and indeed several of us have exciting programs under way.

Harris Computer Systems is engaged in a joint development program with Case Western Reserve University to develop a hetrogeneous networking capability. It is our belief that a network that can involve only one vendor's system is not an adequate solution to the growing power of distributed data processing. We are, therefore, engaged in a development program that will establish appropriate network protocols aided by some special software and hardware that will enable computers supplied by different vendors to be an effective node on an active network.

I would like to tell you that I think some standardization in this area will happen, but in fact, I do not believe it will. The approach we at Harris are taking is a technique which we believe will minimize the difficulities caused by lack of standardization. Networking and resource sharing is real and is beginning to happen. It should cause each of us to examine his organization and his future requirements to determine if some of these techniques could help him do a more effective job.

Another exciting trend is what we at Harris call big system off-loading. As most data processing systems approach their capacity, we have traditionally looked towards our computer manufacturers for some kind of migration path to a more powerful system. As all of us know who have lived through this kind of a transition, it is frequently painful and expensive. I believe that the Class IV minicomputers will be increasingly used to avoid the necessity for a major system upgrade. Usually, there are a handful of requirements which seem to bottleneck the big system. A careful examination of the capability of today's and tomorrow's Class IV minicomputers can offer tremendous relief in some of these areas and, in fact, increase the effectiveness of the computer center with minimal disruption of existing software.

Harris, for example, offers simultaneous RJE capability to IBM, Univac and CDC systems through standard protocol. The growing recognition of these kinds of alternatives will, in my opinion, drastically alter the traditional migration path of major data processing vendors.

One final trend that is exciting to me is the probable use of cost effective multiprocessor capabilities with fail-soft or graceful degredation features. The experience being gained in the field today, combined with the increased leverage of modern technology will make this a reality and the possibilities are exciting and almost limitless.

From these remarks I believe it is possible to draw a few conclusions. I think we must recognize that minicomputers are not a panacea. None of us should expect to simply put in a new Class IV minicomputer system and have all of the problems disappear. We do, however, for the first time have a viable alternative in considering current and new applications and this alternative was not available to us just a few years ago. It is my belief that the Class IV minicomputer is useful today and will be an even better tool tomorrow to help us solve the problems of administrative data processing.

MANAGEMENT NEEDS FOR COMPUTER SUPPORT

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University management has many and varied needs for effective computer services in support of their processing and information functions. While promises are made and well intended, the results achieved are too often not in accordance with expectations. The challenge which exists for the computer center managers is to better understand these needs and assist in the development of effective and timely solutions. A manager's perspective of the many needs for computer services and an evaluation of the various problems and frustrations encountered in meeting these needs were presented in this paper.

MANAGEMENT NEEDS FOR COMPUTER SUPPORT

At the outset it might be worthwhile to say a word about my perspective concerning the topic. One of my roles is that of a vice president in a multi-unit university with twenty-two units spread across three campuses. Another is that of a manager in the University responsible for several fairly large-scale operations which are dependent on data processing support. These operations are centralized in an organizational structure which is mixed in terms of centralized/decentralized authority, and one in transition. Thirdly, I am involved through the Board of Directors in a cooperative state-wide computer network which constitutes the means of production for all administrative data processing support in the University. A new computer network, coupled with an institution in transition, trying to catch up in technology and administrative support systems in a short period of time to overcome years of neglect, presents a dynamic environment to say the least. It may represent such an extreme in complexity, confusion, and chaos that my views may be unnecessarily pessimistic or, at best, somewhat removed from the reality of other advanced institutions. However, in talking with colleagues in other institutions for the last several years, I find many attitudes, problems, and hopes common to us all. It is to those common situations that I address my remarks today.

Management's Need for Processing and Information

Every now and then my president, with tongue in cheek, will suggest that it is the president's job to do the worrying and the vice presidents' jobs to do the working. That "working" involves a number of functions as it pertains to data processing support. Vice presidents are usually responsible for line operations which must deliver service to multiple parts of the University community. Everyone is familiar with these activities in accounting and payroll and the business area, but it is also true in areas such as university development, alumni relations, admissions, financial aid, and registration. The top level manager, then, must depend on the computer in one way or another to deliver these services, to control the operations, to analyze costs of operations, and to develop data to demonstrate accountability to internal auditors, the Board of Governors, a coordinating board at the State level, the state legislature and the federal government. At the same time the Vice President is charged with delivering services and supervising on-going administrative operations, he has also the responsibility for developing policies for those operations throughout the University, both operational policies and procedures and governing policies for the University. This requires extensive, accurate and timely management information. Finally, the top level manager is almost constantly in need of data which can be used to develop positions for public policy.

A few examples will illustrate. A budget submission from a State University to a coordinating board or the legislature is far more than aggregating numbers according to a formula; it is frequently a review of educational policies and programs. Data are required to justify the dollars in the budget in terms of the mission of the institution, the effectiveness of existing programs, and the direction of the future programs. Another example is in the area of financial aid policy. What effect does a tuition increase of 30 percent have on a student body? How much should tuition be raised? What effects do changes in federal legislation have on the financial aid operation of the University? This becomes a major policy question when one thinks that even a state institution has between 15 and 20 million dollars in financial aid from one or another source. These kinds of questions require a modeling capability which must be built into adequate computer support.

The management needs at the presidential and vice presidential level are not the only ones in an educational institution. In fact, there are multiple management requirements. Deans of instruction need detailed information to work with students and faculty and department heads; they also need aggregate data to understand and monitor changes within their units. The same is true of directors of operations, whether it is the comptroller, the university director of admissions, the director of wage and salary administration, or the director of employee relations in charge of collective bargaining. Library staff fall in the same category, with a need to make the library function effectively in terms of circulation, acquisitions, and, at the same time, to manage staff operations in a multi-library university system. One can add to these the needs of directors of institutes, academic provosts, institutional research staff. What many people in the computer support area fail to understand about the nature of this environment is that many of these requirements may, in fact, be both competing and conflicting within a given area. When one multiplies the possibility of these multiple requirements being in conflict by the number of areas that a computer center must support, one begins to understand how data processing managers can get confused, can disburse their resources too thinly, can over-extend their jurisdiction, all of which can result in inadequate delivery of service.

I cite a couple of cases to illustrate these competing requirements.

Case No. 1 - Admissions. Last year we had a fiscal crisis in New Jersey that not only jeopardized the state appropriation to the University with an estimated cut of $16 million, but threatened to reduce the enrollment in the University by 7,000 to 8,000 students. The pressure on enrollments put the admissions operation under severe strain, for while the political debates were raging in the halls of the Legislature and the press, the admissions staff were put in a "Catch 22" predicament. They were asked to be prepared to admit and enroll students to reach the first projection (an increase in students) and at the same time prepare to cut that enrollment by 7,000 to 8,000 students. Several months prior to the crisis, a new data processing system had been installed and staff had been consolidated from four locations into one. The demands placed on the data processing system were four-fold:

1. To make it possible to admit students. A student cannot be admitted without staff interaction with the system.
2. To provide descriptive data for management to use in describing to political leaders the impact of cutting enrollments. This meant demographic data on the population, projections about selectivity, quality of the applicant population, predicted yield.
3. To provide management data weekly so that decisions could be made about the number of students that might be admitted on a semi-rolling basis throughout the spring months. Waiting lists had to be established in order to attempt to hedge against the uncertainty of the situation.
4. To provide data to the deans of the respective units about the

> students applying to their units. For the first time, a student could apply to multiple units of the University on a single application so that the overlap in applications increased substantially over prior years.

I believe one can see easily the potential conflict in requirements. I needed special computer runs to give me summary data that I could use with the University's various publics. My director of admissions needed detailed applicant lists by high school with the overlap analyzed to know the nature of the population with which she was dealing. The deans and the admissions officers working with those deans were anxious to know what was happening and, moreover, wanted that information in more-or-less the same form that they had received it in prior years. Finally, some of the admissions staff resented all of the coding necessary to maintain the system, so their requirements were for simplicity. I will not go into the details of the situation. Instead let me simply say that the system itself, in my judgment, made it possible for the University to be responsive to the political demands of the moment and at the same time control its internal operations. Others, however, blamed the admissions system for many of the operational difficulties that were experienced.

Case No. 2 - Registration and Billing. In a University that is going through a transition from many virtually autonomous units to one with a balance between local autonomy and university governance and control, the variability of procedures within units and the lack of discipline across units is a common phenomenon. Registration and billing is a good example. In the past, there was virtually no link between a student's registration and his having to pay his bill until well into the semester when a reconciliation was made by the cashiers' offices. For the past year, we have tied the two together and now require students to make appropriate contact with the cashier's office before they can register. If a student has a "hold" on his record, he must settle that with the cashier's office before he is able to register. This results in a number of students who preregistered being "knocked off" the registration system, whereby they must come back into the system through the dean's office during a late registration. This kind of control is very important from the standpoint of the fiscal accountability in terms of our student accounts receivables. So the University's audit committee, the Vice President and Treasurer, and others understand the importance of this control. At the same time, having students "deregistered" is a pain and a problem for the deans because a) they want to get as many students registered as possible since their faculty lines are based on the number of full time equivalent students and b) they must reschedule and counsel the students who are deregistered; their plans for their class and section sizes may also be disrupted. Thus, when students are not permitted to register, deans may accuse the registrars of not serving them adequately. Or, since one difficulty may also lie in the long turnaround time and poor quality control of the data processing system in handling the additions, deletions, and changes, data processing is blamed. The situation becomes confused: Is it a registration problem? Is it a data-processing problem? Is it a financial policy problem? In any event, the accountability function is in conflict with the service function and data processing and administrative services are caught in the middle.

Views of Top Level Management and Data Processing Toward Each Other

Now let me turn to a description of the attitudes that frequently prevail in the environment that I have described.

First, let me say a word about how a number of top level managers view computers and data processing. First of all, there is the manager who does not see the relationship between data he wants for management purposes and the time requirements and accuracy of data input into a computer system. For example, he may want to know the total enrollment on the first day of classes, but not understand that academic schedules do not require students to register until ten days into the term. Or, he may want to have aggregate data on subjects or elements that do not exist on the data base. It is very difficult to convince him that you can not report data that you can not collect. Other top managers are suspicious of computers and believe that it is the data processing staff that make reports inaccurate and incomplete. They see computers as threatening and somehow diminishing the humane aspect of higher education. On the other hand, there are those managers who believe that technology cannot only save the world, but hassled administrators as well, that both greater service and economy can be achieved through the use of a complex machine. But, few top level administrators in higher education see the computer as the main means of production. Some will acknowledge the computer as a support mechansim or a record keeper. However, those days are over for many of us and the computer has become a major link in a production process. Since higher education is seldom thought of by academic administrators as a production process, thinking of computers in this fashion is a foreign notion, and to some, a repugnant one. We have accepted mail rooms, telephones, technology in medical schools and in engineering schools, even computers in generating payroll checks--but not yet in areas close to the academic heart of the community, i.e., admissions, faculty workload, control of space, or financial aid.

The reality of the situation, I believe, is that a) computers are costly, a fact which must be recognized, b) the technology has in a number of institutions outstripped the expertise to accommodate it and control it, and c) many institutions are structurally ill equipped to fully utilize the potential resources of complex computers. Some of top management may be ignorant, disinterested, and lack expertise; middle management may be uncoordinated and in an environment in which functions have been splintered and dispersed so that control is seldom possible; and data processing staffs themselves may be too far down in the hierarchy, or, at the very least, the victims of very bad public relations. Because of these attitudes and images, and because the computer is not seen as integral to the day-to-day operational process, top level management frequently relegates too much to the data processing manager and, in effect, tells him to go into the closet and come out only when he has the answers.

We are dealing, then, with at least three views of the world--what I have called a Troublesome Triangle of Tensions among top level management, middle level management, and data processing management. In this world, the data processing manager usually assumes one of three roles which I am sure you will recognize. The first I call Kenny, The King. He believes that with his expertise and with the very expensive hardware for which he has responsibility, he is in a position to create an empire, with the data processing operation at the center of the administrative universe. He is driven by a "territorial imperative" that seeks to control everything and anyone that has anything to do with computers on campus. He knows he is indispensible and he wants to remind everyone of it every day. The second personality is that of Meeky Mouse, the yes man who agrees to anything a top manager suggests. He knows that technology is the answer and he feels required to deliver today or tomorrow anything that the world of technology promises in the immediate future. Thus, he cannot say no, and he promises too much. Moreover, he would rather say yes than have to try to educate the top manager who may be quite ignorant. A third personality is Bully Bureaucrat. He knows he cannot perform miracles today, tomorrow, or even next week and so he sets about protecting himself and making the record so that when criticism does come, he will have a scapegoat. Everytime a request for services is made, he needs one man-month to conclude he needs more resources. Bully Bureaucrat will tie up an organization with paperwork so that frequently more manpower is spent in planning, justifying, and documenting than in actually changing a system or delivering a service. Buzz words constitute his vocabulary.

How do these personalities develop? Since I do not believe that data processing managers are innately different from other people, there must be forces and conditions which move them toward one of these molds These, in turn, affect the operating environment for much of the administrative work in the university. On the one hand, I believe that top level administrators contribute much to this condition. A few of the factors may be the following:

Possible Shortcomings of Top Management:

1. They leave the setting of goals to Data Processing instead of understanding that goals can be set realistically only by top management.

2. They leave the setting of general specifications in the development of application systems to Data Processing when they should recognize that general specifications must come from the user side of the house with the involvement of both top level and middle level management.

3. They assume no responsibility for the development or implementation of a new system for they leave the control of data, both input and output, to Data Processing and assume that it must be handled internally within Data Processing.

4. They leave the cost justification and budgeting to data processing and then complain about the inefficiency and cost limits of the entire operation.

5. They let Data Processing identify the users.

6. Finally, they leave the setting of priorities, both in terms of developmental work and maintenance of operations, to the Data Processing manager.

On the other hand, the Data Processing manager falls victim to a number of situations.

Possible Shortcomings of Data Processing Management:

1. He undertakes design work his staff is not equipped to do.

2. He thinks only in terms of software and data processing operations rather than in terms of an entire administrative system.

3. He ignores the necessity of training, both in his own staff and in the administrative offices throughout the university.

4. His internal structure may be organized to jeopardize and thwart change rather than to accommodate it.

5. His staff are generally not organized to deal with the user in a productive way, especially if there are multiple users.

6. He is ineffective in monitoring, controlling, and auditing developmental projects.

7. He may frequently generate plans for changes in hardware configuration without consultation of the user and without integration with the user's plans.

8. He may assume responsibilities that should be focused elsewhere, i.e., the setting of priorities.

9. He may not be able to relate services to dollars, and thus, without a chargeback system, cannot help users make intelligent decisions.

10. He may assume that the university, in its administrative aspects, functions like a business enterprise.

The Delineation of Responsibilities Among Top Management in Data Processing

In order to change the environment and to move toward a more productive operation, I believe that university management and data processing administration must delineate the responsibilities of each. This delineation may vary somewhat from institution to institution, but I think there are checklists such as those proposed on the following page, which can be helpful in trying to work toward a clarification of roles.

Functions Top Management Should Perform

1. Set goals and general direction.

2. Set general specifications.

3. Define the information needed from the system.

4. Determine how data must be prepared and controlled in the user area.

5. Decide the proper balance of centralized vs. decentralized processing.

6. Determine to what extent the system is to guarantee the implementation of policy or to serve as record-keeper.

7. To specify the interfaces that are required among user areas and data processing.

8. Examine the efficiencies and cost trade-offs of specific systems and operations.

9. To require audits of developing systems and operations.

Functions Data Processing Should Perform

1. Advise on the relationships of management information systems and day-to-day operations.

2. Spell out alternatives between generalized retrieval packages and production reporting capabilities.

3. Make proposals on the structure of the data base.

4. Develop plans for data base management alternatives.

5. Advise on micro or macro approaches in developing systems.

6. Take responsibility for implementing projects under general user project direction.

7. Provide stability in operating environment. Provide reliability through quality control and production control procedures.

8. Develop and maintain accurate, readable, usable documentation.

Now there are some risks in presenting the responsibilities in this fashion. It is possible that the University manager and the data processing administrator can become so self-conscious about their respective roles and not stepping on each other's toes that it becomes an Alphonse and Gaston situation: each waits for the other. Or, specific listings of responsibilities might lead to pointing fingers, one saying that the other hasn't fulfilled his function. If this happens, nothing gets done.

The list above emphasizes the functions of top level users. In the last several years, the data processing administrator has learned to give constant lip service to the motto "involve the user". Many writers and speakers in recent years have emphasized the importance of the role of the user. For example, Len Swanson writing in the Spring 1975 issue of the Educom Bulletin writes:

> "Among the most important elements in developing administrative information systems are clarifying administrators' expectations about the role and purpose of the system and gaining the required commitments of time and money for its development. The first step in accomplishing this can be taken by involving users in all phases of the development process and increasing their awareness of the potentials and limitations of the system."[1]

This is more easily said than done, and it is important to strike a balance. For example, some data processing managers make the mistake of assuming that anyone outside the computer center is a user. They then get bogged down trying to serve everyone who places a demand on them. Or, the data processing administrator, in the name of user involvement, can try to involve too many users simultaneously in trying to reach consensus on specifications and policies. The project team and its advisors get bogged down because leadership, direction and authority are too much dispersed. It is important to know which users are key for particular kinds of decisions. The data processing manager must learn to recognize points of leverage and sources of effective authority.

Finally, the list above describes what might be done, but not how. It is important to recognize that a top-level manager is not going to fulfill every function precisely or completely; neither will the data processing administrator. So what can be done? There are no easy answers or short-cut solutions, but I do believe that both high-level management in an institution and the data processing leadership must development an awareness of the environment and a sensitivity to the needs and requirements of each other. I can think of four specific things: (a) recognize the elements required for change, (b) recognize the elements of stability, (c) organize in order to be responsive, (d) keep in perspective the entire process of production, not simply the computer center. Take each of these one at a time.

a. The Elements Required for Change: Top level management must establish and clarify the organizational structure, the roles of staff, the deployment of operations staff, and the codification of policies. Specifically it must provide data processing with a policy-making mechanism, a priority-setting mechanism, and a planning environment with regular review of dollars, manpower, hardware, and developmental projects. If things are not in place, the data processing manager must seek to have them clarified and established. He must look for points of leverage among top management and make requests for the planning and policy mechanisms if they are not in place. Sometimes outside consultants can serve as an instrument for change by focusing on specific needs in the data processing area.

b. Stability: The data processing manager must provide a predictable environment, not predictable scapegoats. He must familiarize users with a known and stable operating system, and alert major users to planned changes in the system. Further, he must provide recommendations and plans for data base management systems with proper data base administration. If the data processing administrator is not providing conditions of stability, top management must become involved in facilitating the development of the environment either through staff changes, increased supervision, and/or changes in the configuration of the center.

c. Responsiveness to Clients: Bureauracracies tend to get set in concrete; they become inflexible and immovable. This is a real danger in the computer center even when there are well-established plans for change. In order to avoid this, data processing must organize in a way to facilitate the constant adjustment of resources, especially in the development of new systems. It must also designate trouble-shooters who can respond quickly to crises situations. It must sound the alert to top management when there are predictions of trouble. If these conditions do not exist, it is management's responsibility to shake things up a bit.

d. The Process of Production: Both university management and data processing administration must see the process of production as a continuous process with extensions on all sides of the computer center. I call this view "portal to portal". It begins with the mailbox coming into the university and ends with the mailbag going out of the university. The attached chart depicts this in a simplified fashion. There is an interdependence among administrative staff and data processing staff that must be fully recognized. Software changes in the computer center lead to changes in the operational areas which interact with the computer center; these in turn lead to changes in the various publics. This ripple effect can be quite explosive sometimes if procedures are not planned adequately and processes are not controlled and implemented on schedule.

In conclusion, I believe that much of the success of an effective computer center from the standpoint of top management will depend on the development of the kinds of awareness mentioned above, diplomacy, goodwill, and open communications. The data processing manager must understand that he, too, is managing people and not just machines. If his staff cannot come to know thoroughly the users' needs they will become ineffective; or, if they become bogged down in bureaucratic red tape, users will find shortcuts and alternate paths of developing systems, even to the point of hiring staff themselves. One of the main ingredients for data processing staff is courage. Someone said that "he who sticks his head above the crowd will be hit with rotten fruit." If one cannot handle the fruit and laugh at himself and the situation as he gulps it down, he may be better off somewhere other than in data processing in an academic community.

* * *

Magazine:

[1] Len Swanson, "Administrative Systems Development: Sharing People Resources," Educom, Spring, 1975, p.2.

ADMINISTRATIVE DATA PROCESSING: THE CASE FOR EXECUTIVE MANAGEMENT INVOLVEMENT*

An Overview

John F. Chaney
Associate Director
The National Center for Higher
Education Management Systems (NCHEMS)

Considerable attention has been given to improving the effectiveness of administrative computing because of its increasing importance to most planning, management and operational activities in colleges and universities. But most of these efforts have been directed to technical considerations (hardware and software to be used, programming standards and procedures, and so on) or to isolated applications required by middle management. In order to effect the kinds of changes that will serve the needs of decision makers and managers in postsecondary education, the involvement, as opposed to passive support, of the chief executives is crucial. Involvement encompasses leadership in (1) developing and defining objectives, goals and policies for information systems, (2) integrating information systems with other administrative functions, and (3) developing information systems.

A copy of the publication is available from The National Center for Higher Education Management Systems, P. O. Drawer P, Boulder, Colorado 80302.

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*Based upon an NCHEMS publication of the same title by Ronald W. Brady, John F. Chaney, George W. Baughman, and Robert A. Wallhaus.

MANAGEMENT INVOLVEMENT IN THE OHIO BOARD OF REGENTS' UNIFORM INFORMATION SYSTEM

A CASE STUDY

George W. Baughman
Director
Special Projects
Ohio State University
Columbus, Ohio

This paper discusses the guidelines applied by the Ohio Board of Regents for executive involvement in the development and implementation of information systems. The study deals with the way in which the Ohio Board of Regents fostered wide-scale institutional involvement in the development and implementation of a detailed state-level information system.

MANAGEMENT INVOLVEMENT IN THE OHIO BOARD OF REGENTS' UNIFORM INFORMATION SYSTEM
A CASE STUDY

George W. Baughman
The Ohio State University

BACKGROUND TO THE CASE

When Ron Brady, John Chaney, Bob Wallhaus and I authored "Administrative Data Processing: The Case for Executive Management Involvement" for NCHEMS in 1975, we concluded with six guidelines for implementation:

1. Recognize the distinction between the substance of the decision process and the logistics and technology of planning/analysis budgeting control systems.
2. Recognize the need to reorganize administrative structures on a function-oriented rather than a process-oriented basis.
3. Implement a formal long-range planning process that utilizes the information systems and relies upon the budgetary and allocation systems.
4. Recognize realistically the costs, the benefits, and the time needed for development.
5. Create wide-scale involvement at all levels in all relevant departments.
6. Create an environment for administrative units that promotes mutual interdependence rather than self sufficiency.

This year, when asked to update our work for this Conference, I selected a case study to demonstrate the successful application of these guidelines. I must hasten to point out that my case subject, the Ohio Board of Regents, cleverly managed to apply these guidelines nearly nine years before we authored them. However, the fact that their Uniform Information System has served statewide decision makers directly for over ten years is most dramatic evidence that management involvement can work. A secondary criteria for my selection of the Regents' system is that I have been involved with aspects of the design, use and maintenance of that system from both an institutional and statewide perspective since its inception.

This case study is an ex-post analysis of how the work of the executive management of the Ohio Board of Regents in designing, installing and using a Uniform Information System clearly illustrates the six guidelines we recommended. For those who are interested in the details of the System I suggest three references:

1. "The Ohio Board of Regents' Uniform Information System and Resource Analysis Model" - William B. Coulter, Vice Chancellor for Administration, The Ohio Board of Regents, College and University Machine Records Conference Proceedings, May 1972. This 22 page article discusses how the data bases have been built, maintained and used for reporting and resource analysis purposes on an inter-institutional basis.

2. "State Budgeting for Higher Education" - John D. Millett, Chancellor, The Ohio Board of Regents, General Session Address to the College and University Machine Records Conference, May 1972. A 25 page discussion of how the Uniform Information System is an integral part of the budgeting philosophy, practices and procedures in Ohio.

3. "Ohio Board of Regents' Uniform Information System Procedural Manual" updated annually since 1967 and contains the detailed definitions, formats, codes and conventions for submitting common coded transactions for students, faculty, financial, space, course and course registration records.

   In addition, it contains the description and logic by which subsidy entitlement is centrally calculated based on individual student registrations and institutional course inventory records.

For purposes of our discussion today it is sufficient to know that the Ohio Board of Regents' Uniform Information System has, since 1967:

- Collected uniform unit record data on each student, each course registration, each faculty and teaching staff member, each room and each course offered.
- Collected aggregate data on budgets and expenditures by program and function and for non-instructional staff by type and program.

- Used these data to prepare over 40 profile reports (Exhibit A); a resource analysis of instructional expenditures, staffing, students and space by program and level (Exhibit B); and to calculate institutional subsidy entitlement based on program and course level differentials (Exhibit C).

EXECUTIVE INVOLVEMENT BY GUIDELINE

1. Distinguish between the substance of the decision process and the logistics/technology of systems.

From the beginning, Chancellor Millett differentiated between the substance of the decision process and the logistics/technology of the system. In the mid-1960s Ohio was faced with the problems of greatly increased demand for state support for existing and new institutions of higher education. To control this growth and provide for equitable distribution of state subsidy Millett insisted on a decision process that used expenditure based, program and level of instruction differentiated, budget models.

As a former state university president, he was aware that the common information about enrollments, staffing, space and costs by program and course level, that he needed to support this decision process simply did not exist. But because it was vital to his decision process he insisted that it be created.

He was willing to delegate logistics and technology to others and the various "players" in that realm included two consulting firms that helped develop data collection formats and output reports, various staff members from universities that were used to define sub-systems, task forces that fought out the definitional issues and the State Department of Finance that provided programming and computing on a contract basis. Coulter, as Program Officer, coordinated these efforts most effectively.

The extent of delegation of logistics and technology to others is dramatically illustrated by the fact that the Ohio Board of Regents has never had a computer systems analyst or a computer programmer on its staff and yet its system annually collects and processes unit record data from 13 senior institutions and 48 two-year campuses with over 350,000 students.

2. Reorganize administrative structures to reflect function.

Because each institution in Ohio operates with a separate Board of Trustees, the Board of Regents have little to say about administrative structures. Indeed they have generally avoided the area of how should an institution be organized or how should it spend its resources. However, in planning and allocating state resources the Regents have adamantly pursued a functional rather than process oriented philosophy, and their Uniform Information System clearly reflects it.

Most simply, the system collects information that reflects Millett's premises that:

a. State government is principally interested in the instructional function.

b. The instructional function needs to be differentiated by program and by level of instruction within program.

c. Expenditure objectives and subsidy should be set based on common support factors by program and level weighted by enrollments and NOT by object of expense (e.g., salary increases) or institutional history.

The Resource Analysis Model, which combines student faculty, space and financial data by program and level contains fifty programs and five levels within each program or a total of 250 functional cells. These are the basis for comparing institutional uses of resources and arriving at common expenditure models by function.

3. Use the Information System in the long range planning process and budgetary and allocation systems.

From the above it should be apparent that the Uniform Information System is an integral part of the Regents' budget and allocation system. It provides the quantitative basis for establishing budgets and the control system for both calculating and auditing subsidy entitlement. In addition, the system provides the profile data that has been used in State Master Plans and the conceptual structure for those plans.

Most significantly, from a long range planning standpoint, the system has provided the allocation basis by which six of the seven new senior institutions and over 30 new two-year institutions have been added to state assisted higher education in Ohio over a 9 year period.

4. Recognize realistically the costs, the benefits and the time needed for development.

Millett, as a former president of a state university in Ohio, and Coulter, as a former legislative analyst and the first Executive Director of a voluntary council of presidents of the six state universities, were both well aware of the benefits of having comparable, functionally oriented statistical and cost data.

Costs and time needed for development were controlled at a central level by heavy use of outside contracting. Institutions, which really bore the brunt of implementation, simply shelved many of their internal plans in order to respond to the enormous initial demands of the system because of the veiled threat of loss of subsidy. For the most part schedules were met although the existance of pure data did not impede the Chancellor from proposing and using subsidy models that were eclectically derived.

Continuing computing costs of the systems are remarkably low and indeed have been reduced by nearly 50% in the past four years although the volume of reporting has increased substantially. In 1972, the Regents spent about $125,000 annually to support the central processing of over 1.5 million unit records on course registrations, room utilization, faculty service, etc. This year that cost will be in the neighborhood of $65,000 largely through the use of streamlined programming, strategic use of data center rate differentials for off-shift processing and microfiche outputs.

5. Create wide-scale involvement at all levels and in all relevant departments.

Once the precepts of what the executive management of the Regents wanted the system to provide were set forth there was wide-scale involvement of institutional representatives. Essentially, the system data definitions came in the form of eight, 80 column, card formats for reporting:

1. Student characteristics for each student.
2. Course enrollments for each student.
3. Course inventory for each course.
4. Faculty characteristics for each faculty member and teaching assistant.
5. Faculty service report for each faculty member and teaching assistant.
6. Building inventory record for each building.
7. A room inventory record for each room.
8. A classroom and laboratory utilization record for each room used for a course.

In addition, there were forms developed for reporting a total personnel inventory by program and financial budget and expenditure data.

Task forces of registrars, institutional researchers, space analysts, budget and financial persons, etc., were assembled to iron out consistent definitions and to agree on reporting conventions and procedures.

At the analytical level, task forces were also assembled to discuss the procedures for automating the subsidy calculation from student and course records and to work out the rigors of providing institutionally consistent data for the Resource Analysis Model. These task forces have been assembled again from time to time when major changes in subsidy formulas have been introduced or when new data requirements such as E.E.O., or inflation adjustments to models have cropped up.

6. Create an environment for administrative units that promotes mutual interdependence rather than self sufficiency.

The long range implications of the Regents' Uniform Information System are probably the greatest in this area. For the first time financial officers had to deal with registrars on a unit record compatibility basis. The "course inventory" had to relate to every student and every room using instructional space. Faculty service reports had to allocate time to each cell where there were enrollments, etc.

For most institutions this was the first time that rigorous functional relationships had ever been applied to their data. In many cases this application encouraged the development of institutional data systems. This,

> of course, has in turn been instrumental in improving the technical and logistical aspects of planning/ analysis budgeting control systems.
>
> The character of this system - where a program that is "common" receives common support regardless of what an institution chooses to spend - forces institutions into a mutual interdependence. Arguments that it costs more at "institution X" must be made on programmatic grounds not historical accident. Instead of institutional bickering over who got what share of the pie, the name of the game is to better understand the "mutual" program cost differentials and to demonstrate programmatic institutional differences.

Thus, we come full circle on our guidelines in that, with close executive involvement, technology has assisted greatly in changing the substance of the decision process. And that, I believe, is what our book is about.

Page 1 of 2

EXHIBIT A

PROFILE OUTPUT REPORTS OF THE OHIO BOARD OF REGENTS' UNIFORM INFORMATION SYSTEM

ENROLLMENT DATA

INVENTORY and Public Information Reporting

1. Student Counts by Major Field of Study
2. Student Counts by Age and Rank
3. Student Counts by Day and Evening Enrollment
4. Student Load (in credit hours of registration) by Major and Rank.
5. Student Counts by Sex and Rank
6. Student Counts by Sex, Marital Status and Living Arrangements
7. Student Counts by State and County of Residence.

UTILIZATION

1. Full-Time Equivalent Enrollment by Academic Program and Rank of Student.*
2. Full-Time Equivalent Enrollment by Academic Program and Level of Course
3. Class Size Analysis by Academic Program and Level of Course
4. Subsidy Calculation.

STAFFING DATA

INVENTORY and Public Information Reporting

1. Academic and Non-Academic Personnel Inventory (Manually prepared report)
2. Faculty Inventory
   a. Highest degree earned, by Academic Program and Rank
   b. Doctoral College, by Academic Program and Rank
   c. Salary Analysis
      - High, Low, Mean, by Academic Program and Rank
      - Frequency Distribution, by Academic Program and Rank
   d. Full-Time Equivalent Counts, by Academic Program and Rank
   e. Term of Contract

UTILIZATION

1. Faculty Teaching Loads
   a. Credit Hours Assigned
   b. Contact Hours Assigned
   c. Student Credit Hours Produced
2. Faculty Service Analysis
   a. By Primary Functions
   b. By Level of Instruction, within Instructional Function
3. Distribution of Overall Teaching Load
   a. Among Ranks of Staff
   b. Among Academic Program Areas
4. Costs Assignable to Academic Programs and Course Loads
   a. Full-Time Equivalent Staffing Costs*
   b. Salary Costs*

FINANCIAL DATA

INVENTORY and Public Information Reporting

1. Operating Income
   a. Statement
   b. Budget Estimate
2. Application of Current Income Available for Instructional and General Purposes
   a. Statement
   b. Budget Estimate
3. Instructional and General Expenditures*
   a. Statement
   b. Budget Estimate
4. Departmental Instruction and Research Expenditures*
5. Separately Budgeted Research, Income and Expenditures

EXHIBIT A
Page 2 of 2

6. Public Services, Income and Expenditures
7. Auciliary Services, Income and Expenditures
8. Student Aid, Income and Expenditures
9. Summary of Income and Expenditures

UTILIZATION

1. Expenditures by Object and by Academic Program*
2. Income and Expenditures Per Full-Time Equivalent Student

PHYSICAL PLANT DATA

INVENTORY and Public Information Reporting

1. Land Inventory and Use Report
2. Building Inventory Report
3. Room Inventory Report*

UTILIZATION

1. Classroom and Laboratory Utilization Report*

*INPUTS to the Resource Analysis

EXPENDITURE AND RESOURCE REQUIREMENTS

FOR 100 FTE STUDENTS

DATE: 08/10/71

LEVEL: LOWER DIVISION U. G.

PROGRAM: MATHEMATICS

		BGSU	CNTRL	CLEVE	KENT	MIAMI	O-S-U	OHIOU	WRGHT	AKRON	CINCI	TLEDO	YTOWN	TOTAL
FINANCE	DEPARTMENTAL INSTRUCTION													
	FACULTY SALARIES	50472	31098	39552	47305	47630	23270	52168	37138	30847	35783	54476	45947	38038
	OTHER STAFF	3842	2217	6928	10024	3296	13605	3075	6925	2814	4263	1317	1495	7124
	OTHER EXPENSES	1630	6021	3010	1360	3370	1290	1054	7831	3146	4450	1226	1172	2433
	INSTRUCTIONAL SERVICES	2980	1854	5938	3753	5165	3496	2546	7834	2591	2215	2556	1286	3421
	LIBRARIES	7033	9517	9369	7904	8063	6434	8358	9297	6504	5790	7669	5309	7092
	STUDENT SERVICES	7669	11877	11879	10842	10995	8439	8148	12689	7425	7547	10071	6572	8938
	GENERAL EXPENSE	7991	16278	5910	9489	5356	9406	7371	5926	10632	12928	10481	5719	9052
	ADMINISTRATION	6373	13516	7196	4959	4891	2758	6638	9298	4795	3876	6061	6951	5066
	PUBLIC SERVICE	440	0	968	440	566	1386	570	0	0	325	876	516	734
	RESEARCH	82	0	206	424	190	1626	4068	0	0	2368	0	0	1136
	STUDENT AID	3543	8750	1709	3931	2822	12271	3889	701	1614	7326	2150	154	6085
	PLANT	16687	26887	21330	11251	16522	14407	18854	10640	10063	11[illegible]	12592	14369	14471
	AUXILIARY SERVICE	12880	11072	4846	7654	8327	4076	9045	2274	2046	66[illegible]5	0	2462	5424
	TOTAL	121628	139092	118846	119344	117198	102471	125790	110558	82482	108578	109480	95956	109020
STAFFING	FACULTY / 100 STUDENTS	4.6	4.1	3.4	3.5	4.7	3.8	3.5	3.8	2.7	3.5	4.1	4.2	3.8
	DEAN + DEPT. CHAIRMAN	.3	.1	.0	.0	.2	.0	.0	.0	.0	.2	.0	.0	.0
	PROFESSORS	.3	.4	.0	.6	.3	.0	.6	.0	.0	.2	.3	.0	.2
	ASSOC. PROFESSORS	.2	.2	1.1	.5	.3	.1	.3	1.0	.8	.3	.7	.7	.4
	ASST. PROFESSORS	1.6	.4	1.0	1.0	1.9	.3	1.2	.8	.8	1.1	1.2	1.4	.9
	INSTRUCTORS	.6	3.0	.3	.4	.2	.0	.7	.3	.5	.7	.6	.7	.4
	GRADUATE ASST.	1.3	.0	.2	.8	1.2	2.5	.4	.7	.0	.5	1.0	.0	1.2
	OTHER	.1	.0	.8	.0	.3	.7	.0	.8	.3	.2	.1	1.2	.4
	ACTUAL FACULTY	35.8	7.2	23.4	24.6	22.8	122.9	25.8	20.9	17.1	48.4	27.0	28.7	404.6
STUDENTS	ACTUAL ENROLLMENT	765	173	670	686	481	3168	734	547	614	1371	646	673	10528
	LOWER DIVISION UNDERGRAD	674	157	561	610	437	2864	638	479	557	1236	570	584	9367
	UPPER DIVISION UNDERGRAD	86	17	108	76	42	279	93	66	54	116	55	88	1080
	MASTERS CANDIDATES	5	0	1	0	3	17	2	2	2	6	3	1	42
	PHD CANDIDATES	1	0	0	0	0	6	0	0	0	1	0	0	8
	PROFESSIONAL GRADUATES	0	0	0	0	0	1	0	0	0	13	17	0	31
SPACE	ACTUAL SPACE (100 SQ.FT.)	137	37	66	64	51	358	143	51	50	106	61	60	1190
	SPACE / 100 STUDENTS	1797	2227	1060	948	1083	1172	1953	995	873	811	960	940	1162
	CLASSROOM	1797	2227	1050	683	1083	1073	1953	951	873	685	536	940	1094
	LABORATORY	0	0	0	238	0	53	0	43	0	19	0	0	36
	OTHER	0	0	9	25	0	44	0	0	0	106	23	0	31
	* INCOMPLETE													
	ENROLLMENT	0	0	0	0	0	0	0	0	0	0	0	0	0
	FACULTY	0	0	0	0	0	0	0	0	0	0	0	0	0
	SPACE	0	0	0	0	0	0	0	0	0	0	0	0	0

EXHIBIT B

EXHIBIT C

PROPOSED SUBSIDY LEVEL ENTITLEMENTS BY PROGRAM AND COURSE LEVEL OHIO BOARD OF REGENTS 1976-77

Program	General Studies	Baccalaureate	Masters & Profession	Doctoral	Medical
Soc. & Behavioral	I	I	II	I	0
Math	I	I	II	II	0
Bus. Admin.	I	I	I	I	0
Computer Science	I	I	I	I	0
Education	I	I	I	I	0
Home Economics	I	I	II	I	0
Military Science	I	I	0	0	0
Off-Campus	I	I	I	0	0
Humanities	II	II	II	I	0
Biological Sciences	II	II	III	II	0
Art	II	II	II	II	0
Journalism	II	II	II	I	0
Social Work	II	II	II	I	0
Library Science	II	II	I	0	0
Interdisciplinary	II	II	II	I	0
General Education	II	II	II	0	0
Tech. College G.S.	II	0	0	0	0
Architecture	0	II	II	0	0
Agriculture	0	II	III	II	0
Public Admin.	0	II	II	I	0
Physical Sciences	III	III	III	II	0
Physical Education	III	I	II	I	0
Engineering	III	III	III	II	0
Drama, Dance & Music	III	III	II	II	0
Nursing	0	III	II	0	0
Pharmacy	0	III	II	II	0
Allied Medical	0	III	II	0	0
Law	0	0	I	0	0
Medicine	0	II	II	II	II
Dentistry	0	II	II	0	I
Optometry	0	II	II	II	I
Vet. Medicine	0	II	II	II	I

Proposed Subsidy Amounts Per Full-Time Equivalent Student*

	General Studies	Baccalaureate	Masters & Profession	Doctoral	Medical
I.	$ 574	$1441	$2079	$4359	$4632
II.	892	1908	3070	8022	7780
III.	1415	2925	5767	N/A	N/A

*F.T.E. = Autumn Quarter credit hours divided by 15 plus Summer Quarter credit hours divided by 45 except Medical level which are head counts in Autumn and one-third head counts in Summer.

COST BEHAVIOR ANALYSIS: APPLICATION AND USE IN HIGHER EDUCATION PLANNING

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This paper presents the results of studies conducted by the National Association of College and University Business Officers (NACUBO) and Peat, Marwick, Mitchell & Company on cost and revenue behavior analysis and its role in the planning process in higher education.

Cost Behavior Analysis: Application and Use in Higher Education Planning

Higher education has experienced unusual resource allocation difficulties in recent years. Enrollments have leveled while costs have continued to increase. Educators are faced with the prospect of providing educational services in the 1980's to a declining college age population.

More and more, legislators and others are faced with a variety of social and economic conditions reflecting human needs other than higher education. In their minds, these individuals naturally seek to re-examine previous priorities assigned to higher educational programs and related activities. Their call is for "accountability".

Because of these concerns, many have insisted on improved planning as a means of more effectively allocating scarce resources to valuable programs. Many have insisted on cost information to assist the planning process.

This paper is concerned with the use of cost behavior analysis in planning process as performed by institutions of higher education. Planning in the sense that one perceives a need for change in the future and considers how resources may be best allocated to achieve a desired outcome.

Recent Events in Higher Education Costing

Much has occurred recently in higher education concerning the use of cost information in the resource allocation process. In the past, many users of cost, including boards, presidents, legislators, educational commissions and others have used average historical unit cost as the basis for allocating resources. Many allocation formulas have been developed based on this concept. Until recently, The National Center for Higher Education Management Systems (NCHEMS) at the Western Interstate Commission on Higher Education (WICHE) recommended in the Cost Analysis Manual and the Information Exchange Procedures Manual that historical cost was an acceptable method of projecting future cost. The National Commission on the Financing of Post Secondary Education also suggested that historical unit cost information was useful for both historical accountability and in analyzing resource requirements.

Because average historical unit cost was suggested as the means of satisfying these different uses, The National Association of College and University Business Officers (NACUBO) was concerned that this type of cost might be inappropriate for certain uses. Accordingly, NACUBO and its Costing Standards Committee decided to study the subject of costing and cost analysis as it applied to higher education. Peat, Marwick, Mitchell & Co. was asked to serve as consultants to these studies.

Four studies on costing were conducted by NACUBO:

1. The first study resulted in the preparation of a document entitled Fundamental Considerations for Determining Cost Information in Higher Education.[1] This was a "landmark" study which

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[1] Fundamental Considerations for Determining Cost Information in Higher Education, National Association of College and University Business Officers, Washington, D.C., August 28, 1975.

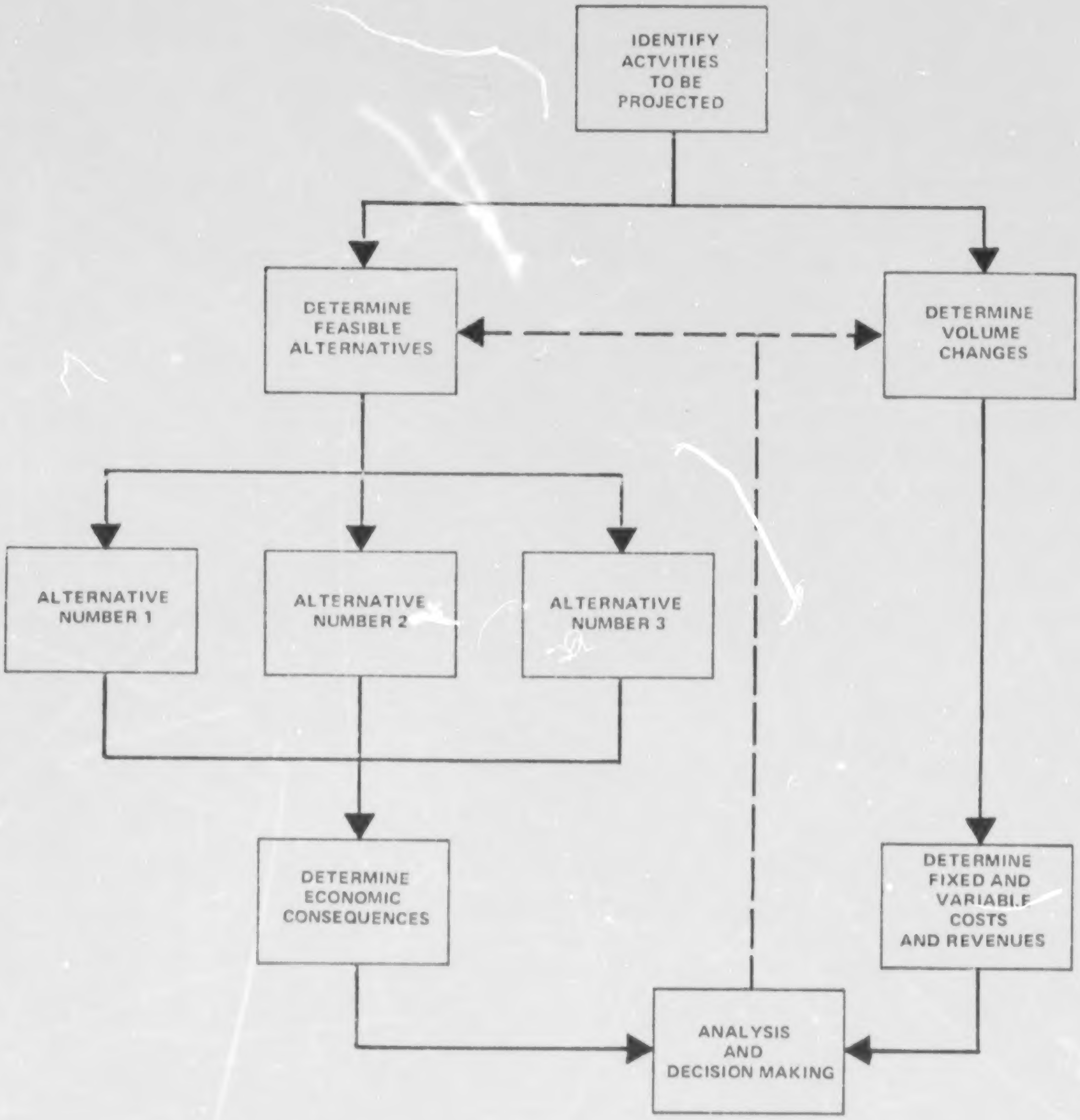
defined for higher education -- costing terms, different cost determination methods and approaches, different cost analysis methods, and most importantly twelve fundamental costing standards. This study was funded by a number of institutions of higher education and related organizations as well as the International Business Machines Corporation.

2. The second study began once basic costing definitions were developed. The second study involved an evaluation of the Cost Analysis Manual (CAM) and the Information Exchange Procedures, Cost Study Procedures (IEP) published by NCHEMS. The most important result of the evaluation dealt with the purposes for which CAM and IEP were designed. NACUBO published a paper entitled Evaluation of NCHEMS Costing Procedures describing the conclusions and recommendations of the study.
3. The third effort resulted from the first two. NACUBO and NCHEMS agreed that certain revisions were needed to the CAM/IEP systems. NACUBO and NCHEMS are now completing the required changes.
4. Finally, it was decided that a study should be conducted on the subject of cost behavior analysis for planning. This paper summarizes the results of that study.

NACUBO Findings on Using Historical Unit Costs

Before discussing cost behavior analysis, it is appropriate to describe briefly the NACUBO findings. The results of the NACUBO studies indicated that historical average unit cost information is most useful for controlling and evaluating performance. Historical information has limited utility in the planning process except for reference purposes.

THE PROJECTION PROCESS


IDENTIFY ACTVITIES TO BE PROJECTED
DETERMINE FEASIBLE ALTERNATIVES
DETERMINE VOLUME CHANGES
ALTERNATIVE NUMBER 1
ALTERNATIVE NUMBER 2
ALTERNATIVE NUMBER 3
DETERMINE ECONOMIC CONSEQUENCES
DETERMINE FIXED AND VARIABLE COSTS AND REVENUES
ANALYSIS AND DECISION MAKING

These studies concluded that planning requires information on future cost behavior. Empirical research indicated that cost in the future often does not follow the historical average. Future cost behavior may be different because as the total number of units of service changes, cost does not change proportionately. Moreover, changes in policy and changes in environmental conditions can significantly influence cost behavior.

Planning Process

Planning involves decisionmaking. It is a process that is used to select a future course of action based on relevant facts. Planning involves the following tasks:

- identifying needs,
- determining specific goals and objectives,
- identifying feasible alternatives,
- developing program plans, and
- preparing financial plans.

To prepare financial plans, it is necessary to project future cost behavior. The projection process is accomplished by performing two different yet related activities:

1. Determining the effect on cost of various alternative courses of action assuming that volume is held constant
2. Determining the fixed and variable components of total cost for alternatives at different levels of volume

This projection process can be described as is shown in Figure 1. A variety of feasible alternatives is identified. The future cost of these alternatives is determined at an assumed level of volume. The financial results are analyzed in light of programmatic and other considerations to determine the appropriate course of action to be selected.

It may be determined that the effect of volume changes on future cost behavior should also be considered for certain alternatives. To examine the influence of volume on the cost of these alternatives, it is necessary to consider the fixed and variable nature of cost behavior. Again, the results are analyzed to select the course of action to be followed.

The projection process is an iterative process in the sense that projections are made for a variety of alternatives at different levels of volume. The process continues until the appropriate course of action is identified.

Alternative Courses of Action

Alternative courses of action consist of changes in (a) goals, specific objectives, and programs, (b) policies, and (c) organizational structure. The scope and content of alternatives are influenced by the existing institutional status, by potential decisions that may be made by administrators and by possible changes in the environment.

In order to project cost effectively, alternatives must be clearly defined. The unique characteristics of the alternative must be determined. These characteristics might include a description of the background, goals and objectives, scope, approach, and specific resources required.

Administrative Decisions

One of the determinants of cost behavior is administrative decisions. Decisions represent matters that administrators can control either wholly or substantially.

A variety of decisions influence cost behavior. These decisions include deciding on the scope and content of programs as well as the way resources will be used to accomplish programmatic objectives.

Clearly, a relationship exists between decisions affecting institutional programs and decisions affecting the use of resources. For instance, student needs determine requirements for instruction, non-academic activities and administrative service functions. Programs are developed in support of each of these needs as well as for research activities. The scope and content of programs determines the resources required to accomplish program objectives. These resources include faculty, administrative personnel and facilities. The use of these resources represents the future cost attributed to program alternatives.

A variety of administrative decisions influences cost behavior. For faculty, future cost behavior is influenced by such decisions as:

- the number of faculty,
- their rank,
- salary levels,
- contract terms,
- workload, and
- retirement policy.

The NACUBO study on cost behavior analysis identifies in tabular form approximately 180 decisions for 18 segments of a college or university. Although certainly not complete, the table serves as a useful check for planners when attempting to project cost.

Environmental Conditions

Future cost behavior is also influenced by changes in the environment which cannot be substantially changed by decisions of the institution. Environmental conditions exist in the social, economic, political, cultural, and physical milieu in which the institution operates but over which the institution has no direct control. Accordingly, they may be defined further as conditions which are directly the opposite of administrative decisions.

Changes in environmental conditions that have an influence on future cost behavior may be illustrated by the following:

- availability of qualified personnel regionally,
- competitive regional personnel pay rates,
- obsolescence of computer technology, and
- market prices for computer equipment.

Similarly the amount of resources available to the institution (i.e., revenue) may also be influenced by the environment. These influences include:

- total pattern of giving nationally,
- level of support for student aid from federal, state, and other sources,
- college age population regionally, and
- college going rate of students.

In each case, these conditions cannot be substantially changed by the institution. As a result, the institution must be prepared to adapt to them in order to survive.

Changes in Volume

Besides determining the projected cost of alternatives, it is also necessary to consider the effect of changes in volume on cost behavior. When making projections at different volume levels, costs should be separated into fixed, variable, and mixed categories. Each of these categories represents the unique behavior of cost in relation to volume. Certain costs are clearly fixed -- for a given period of time they will remain constant regardless of changes in volume within a given range. Other costs are clearly variable -- they have proportional unit relationship to volume, again within time and volume range constraints. Other elements of costs that are not clearly fixed or variable appear to change irregularly in relation to volume. These costs are mixed and must be analyzed and separated into fixed and variable components.

The segregation of cost into fixed, variable, and mixed categories is dependent on two parameters that must be defined before a projection is made:

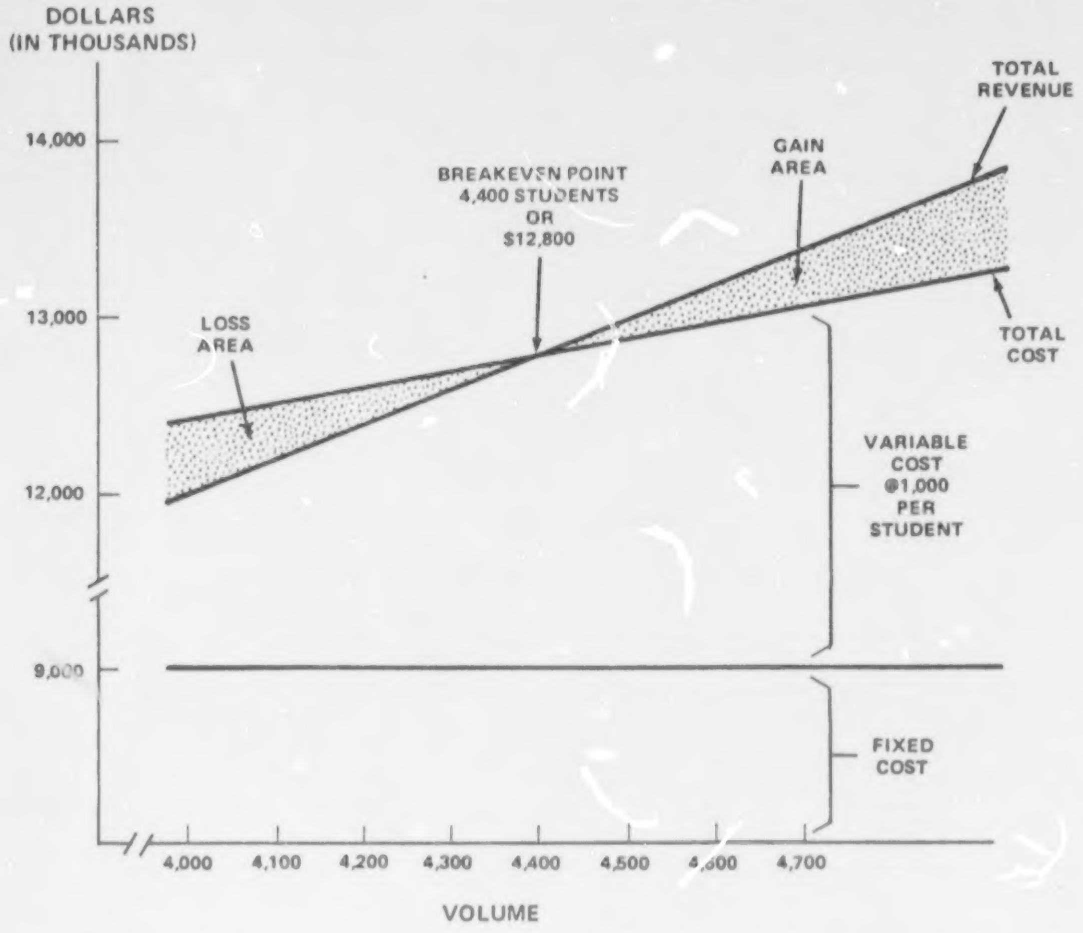
1. Time - for what period is cost being projected? In the short run certain costs may be fixed while in the long run they may become variable.
2. Relevant Range of Service - for what range of level of service is the projection being made? This is determined to focus cost analysis on realistic levels of service. Projections of cost beyond the relevant range are not useful or practical.

Cost Behavior Analysis

Up to this point, we have been talking about such factors as volume, decisions and environment -- all having an influence on future cost

Figure 2

COST-VOLUME-REVENUE CHART



behavior. These factors are considered when projecting cost. Once projections are prepared, it is necessary to analyze cost. Two popular methods of cost behavior analysis are:

- Cost-volume-revenue analysis and
- Differential cost and revenue analysis.

Cost-volume-revenue analysis assists planners in examining how changes in volume will affect cost and revenue. This relationship of volume to cost and revenue is often portrayed on a cost-volume-revenue chart. The chart provides a pictorial representation of fixed, variable, and mixed cost projections described earlier. It shows the cost-volume-revenue relationship at a single point in time within a relevant range of volume.

On the chart (shown as Figure 2) revenue is presented as directly variable with volume. The analysis assumes that revenue per student is constant over the relevant range of student demand for instructional services.

Cost is depicted as fixed and variable. Mixed cost is assumed to be separated into its fixed and variable components. Fixed cost remains constant in total for all levels of volume within the relevant range. Because the chart presents a short run relationship of cost to volume, the predominant amount of total cost is fixed. Variable cost per student is assumed to be the same over the relevant range of student demand being projected.

By presenting the relationship of cost and revenue at different levels of volume, the analyst can identify the point at which equalibrium between gain and loss is achieved. This point is often referred to as the "breakeven point". In the example, enrollment below 4,400 students indicates that the institution will incur a loss whereas enrollment above that point indicates a gain. Revenue per student remains constant while the projected total cost per student increases or decreases as volume is decreased or increased, respectively. This occurs because fixed cost per student decreases as volume increases and increases when volume decreases. Because in the short run there is a high percentage of fixed costs to total costs, an extreme leveraging effect occurs as volume varies above and below the breakeven point. As a result, it is necessary for administrators to understand this leveraging phenomenon and its effect on the net results of operations.

Cost-volume-revenue analysis is a useful tool that attempts to simplify the complex behavior of cost and revenue to volume. It assumes that the following conditions exist:

1. Cost can be identified as fixed or variable,
2. Fixed cost will be unchanged over the relevant range of volume being considered,
3. Variable cost will change proportionately to changes in the levels of volume being considered,
4. Cost and revenue will follow a linear pattern over the relevant range of volume being considered,
5. Efficiency and productivity are to remain the same,
6. The major factor affecting cost and revenue is a change in volume.

Cost-volume-revenue analysis is two-dimensional in the sense that cost and revenue are shown in relation to volume. In the short run, this relationship may be most important because the predominant number of costs are fixed. In the long run, however, other factors (a third dimension) may have a significant effect on cost and revenue behavior. Because universities operate under dynamic conditions, all three dimensions must be considered in analyzing cost and revenue behavior. These factors are decisions that can be made by the institution and changes in environmental conditions.

Another method of analyzing cost is differential cost analysis. Differential cost represents the change in total cost resulting from the addition, elimination, or modification of activities. Differential analysis is a variation of cost-volume-revenue analysis. Differential analysis, however, focuses on those costs that will be changed should the course of action being considered be adopted. In terms of economic consequences, the only costs that are relevant are those costs that will be different as a result of the decision. The fact that other costs may be attributed to alternatives to arrive at full costs is unimportant.

Differential analysis is most useful for comparing the economic benefits of one alternative with those of another. By comparing the differences in cost, educational planners and administrators can assess alternatives in terms of the significance of the net contribution to, or drain upon, institutional resources. Colleges and universities may use this type of analysis to examine a wide variety of courses of action, such as changes in program, changes in the method of providing educational services, and variations in the level of service.

Using a Simulation Model

Often when administrators plan for the future, they consider a variety of alternatives at different levels of service volume. The projected cost behavior of alternatives may be calculated manually. Many times the alternatives being considered are too complex to be examined without computer assistance. In such instances, a computer simulation model may be used which is representative of the actual conditions being examined.

A simulation model is mathematical representation of a real system or process. A model is used to analyze the complex relationships that exist in a college or university setting. A model is merely a tool designed to assist top level administrators in examining the economic consequences of changes in volume, decisions and environmental conditions. It provides an opportunity to examine the consequences of a variety of alternatives before selecting a course of action.

A simulation model is often used most effectively by top-level decisionmakers. These individuals include legislators, commissioners, boards of trustees, presidents, and others interested in determining the future direction of programs. By testing the consequences of alternatives in advance, they are able to establish policies with reasonable forethought and justification. These policies serve as guidelines when preparing detailed long-range financial plans and budgets.

Using computerized simulation planning models to project cost is a valuable exercise. Such a model, however, is only a sophisticated calculator and adding machine reacting to predetermined internal relationships and changes initiated by the planner. Its value to the institution can only be measured by how well the planning results are used in the management process. Considering the economic consequences of a variety of alternatives and then deciding on a course of action is important. Implementing plans and monitoring their progress is more important.

Summary

The principal concepts involved in using cost behavior analysis for resource allocation may be summarized as follows:

1. Cost behavior analysis is a necessary tool in rationally estimating the future economic consequences of various alternatives. When examining the economic consequences of many alternatives, administrators must consider the effect on revenue as well as on cost: the term "cost behavior analysis" as used hereafter is intended to include the study of the behavior of both costs and revenues.
2. Estimating future economic activity encompasses two different but related activities:
   a. determining the effect on cost of various alternative courses of action assuming no change in the volume of service performed
   b. determining the fixed and variable components of total cost for the alternative selected at different levels of volume
3. Alternative courses of action consist of (a) changes in goals, specific objectives, and programs, (b) policies, and (c) organizational structure.
4. The act of selecting and implementing a given alternative requires administrators to make certain specific decisions. These decisions influence future costs. Those acts that influence future cost behavior are referred to as "decision factors."
5. Environmental conditions that are beyond the control of the institution also influence cost behavior. Decision makers should consider possible changes in the environment, referred to

as "environmental factors," when projecting cost behavior for alternatives.

6. For each alternative, cost can also behave differently depending on the projected level of volume of service (for example, projected student credit hours). This phenomenon is referred to as the "fixed or variable" nature of cost. Projections of cost behavior in fixed and variable terms are performed within a relevant range of volume and for a defined period of time.
7. Projections of cost readily can be made manually if only a few alternatives and factors influencing cost behavior are considered. As the number of alternatives and decision and environmental factors increase and become more complex, a computerized simulation model is useful.
8. Cost behavior analysis provides information on the economic consequences of alternatives. Non-economic information about programs, students, faculty, facilities and other considerations should also be examined when making decisions about the future.

These are the essential concepts that should be considered when examining the future economic consequences of alternative courses of action.

FACULTY COLLECTIVE BARGAINING
THE PROBLEMS AND NEED FOR
PLANNING AND INFORMATION SYSTEMS

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Collective bargaining with a faculty union brings unique problems to institutional management. In this paper the needs for planning and information system involvement are described for such system areas as costing and financial management, program planning, personnel, salary and compensation, and resource management.

FACULTY COLLECTIVE BARGAINING: THE PROBLEMS AND NEED FOR PLANNING AND INFORMATION SYSTEMS

The advent of collective bargaining highlights the need to relate institutional management and planning to information systems. This fact was quite apparent during a prolonged period of negotiations between representatives of the Board of Control and the faculty union at Northern Michigan University. Northern, which is an institution of approximately 9,000 students, is in the second year of a two-year pact with the faculty association represented by the American Association of University Professors.

My remarks regarding the problems and need for planning and information systems are designed to be both descriptive and prescriptive. I intend to draw heavily on the experiences we have had to date with bargaining at Northern Michigan University in order to illustrate the relationship between policy considerations and informational needs which emerge in the context of collective bargaining. Ultimately, most "management positions" are "financial positions," as we shall see.

Some characteristics of bargaining strategy will no doubt be reflected in my comments, because it is simply impossible to avoid such references. However, the major areas to be considered in this presentation are as follows:

1. Costing and Financial Management
2. Program Management and Planning
3. Personnel Management and Planning

Central to the process of bargaining is the concept and practice of planning. In his discussion of the planning process, Lahti observes that

> ". . .[the] effectiveness of planning depends on a clear assessment of present conditions (where we are) and insight into future trends (what will probably happen) in light of our desired goals (where we wish to go)."[1]

This statement summarizes the bargaining process rather well.

Assessing Present Conditions: The Pre-bargaining Phase

As I look back, it is clear that we did not have in easily retrievable form much of the data that would become important in bargaining. In preparation for bargaining, very little time was spent on developing or refining our information base because most of our efforts were concentrated on the formation of management positions. Perhaps this was a natural occurrence in that most of us were trying to learn as much as we could about bargaining and bargaining strategy. In short, we did not fully appreciate the importance of having information in hand; and, as a consequence, we undoubtedly spent more time than was necessary on the negotiation of certain issues. To this point I would also add that the faculty bargaining team is entitled to certain data. If you can deliver what they are entitled to in good time, you may be able to avoid public confrontations on the access to information issue. Moreover, bargaining is likely to be much more productive when both sides have a common data base from which their respective positions are derived.

Prior to bargaining, it is essential, therefore, that a thorough cost assessment be initiated. Most institutions have fairly good data on fixed costs (e.g., salary and fringe benefits) and on salary dependent costs (e.g., retirement and F.I.C.A.). Yet, in bargaining information requirements or demands often come as a surprise. Let me illustrate this point as it relates to faculty travel.

Before bargaining began we did not have complete data on past and current expenditures for travel, other than the information which came from departmental expenditure reports. The original faculty proposal asked for an individual travel allotment which would have required a significant increase in expenditures. In pre-bargaining days, funds to supplement departmental travel allocations came from a variety of sources. When we began to probe our records, however, we found that much more had been expended for faculty travel in preceding years than we thought. We had information on expenditures for travel recorded in one or more of our information subsystems, but it was not easy to track. The difficulty we encountered obtaining this data also pointed out the value of having an integrated information system.

Since personnel costs obviously comprised a large proportion of expenditures, we determined as precisely as possible our existing compensation costs. To do so we accessed our master personnel file in order to identify how much was currently being spent on salary and various fringe benefits for the bargaining unit.

An illustration of the kind of data we have in this file and one type of listing appears in Figure 1.

Months Empl.	Rank Sex	Retirement Code	'75 Salary	FICA	WAUSAU	Life Ins.	LTD	Tot Frng Benefits	Total Act. Comp.
09	Assc M	R	$19,052.00	$2,476.76	$656.67	$89.26	$67.20	$3,289.89	$22,341.89
09	Inst F	R	$11,926.00	$1,550.38		$53.51	$67.20	$1,671.09	$13,597.09
09	Prof M	R	$20,809.00	$2,705.17	$656.67	$93.70	$67.20	$3,522.74	$24,331.74
09	Prof M	R	$21,342.00	$2,774.46	$656.67	$98.14	$67.20	$3,596.47	$24,938.47
Department Totals			$73,129.00	$9,506.77	$1,970.01	$334.61	$268.80	$12,080.19	$85,209.19
GRAND TOTALS			$4,675,218.00	$607,778.34	$177,300.90	$21,732.92	$16,732.80	$823,544.96	$5,498,762.96

FIGURE 1

From analyses such as these, it was readily apparent that the so-called "fringe benefit" items added up to a rather significant amount of committed dollars, and it was reasonable to assume that demands for additional fringe benefits were likely to be presented.

I mention these factors only to point out that the possession of information had an impact on the determination of management positions. To be more specific, we developed an initial approach to negotiating salary and fringe benefits from the standpoint of total compensation rather than dealing with salary and fringe separately. Needless to say, this approach was not received kindly.

Bargaining also provided the administration with an opportunity to take a fresh look at an old problem: the cost of accumulated sick leave. For many years the university's sick leave policy had remained unchanged. As faculty retired (and not many have in recent years), they became eligible for a lump-sum payment equal to one-half of the number of unused sick leave days. Barring catastrophic illness, most people bank a fair number of days by retirement time. Have you ever stopped to calculate your potential liability in this area? We did, then set about developing a modified sick leave policy which ultimately took the form of an income protection plan. Our goal was simple: to reduce our future liability by capping sick leave at present day salary rates. Once again, information had a direct bearing on the determination of policy.

If there is a lesson to be learned--and I believe there is--one can observe that it is essential to have accurate and complete information on costs and expenditures as the parameters of administrative positions on bargaining issues are shaped. This is particularly important when multiple-year contracts are being considered, for in such instances the need to project costs becomes even more critical. The management negotiating team, therefore, must be directed to give broad consideration to all potential areas of negotiation. By the end of the pre-bargaining phase, management should have a fairly comprehensive understanding of the goals it hopes to achieve as a result of bargaining.

At this juncture allow me to digress for a moment. I would urge those of you who are or who may be involved in bargaining to seriously consider having someone on the negotiating team who has data manipulation capabilities. This person need not be a computer expert, but he or she should be able to keep on top of informational needs at all times. It is also desirable to have someone in your data processing center assigned to the negotiation support group. Because of the confidential nature of bargaining, there is some risk in having too many hands in the pot, but suffice it to say that it is important to establish good working relationships between the negotiating team and selected persons who are directly involved in information system activities.

Action and Reaction: The Bargaining Phase

For those of you who have had bargaining experience you know that it is often diffucult to predict how the union prioritizes the subjects to be discussed at the table. Generally speaking, I suspect that the initial administrative posture is to react rather than initiate. By this I mean that the faculty is likely to present their proposals first, then management responds. In any event, once formal proposals are on the table planning becomes active, with each side attempting to influence the direction of bargaining.

Earlier I mentioned that management positions are basically financial positions. Personnel decisions have significant cost implications: A decision to promote, for example, has both an immediate and long-term consequence; a decision to grant tenure represents a major long-term financial commitment. In bargaining, however, the initial focus is likely to be on salary considerations. Without going into too much detail about the sparring which took place at the outset of bargaining, I would like to describe the evolution of bargaining on the salary issue and how information needs related to this process.

In our case, the faculty union placed a very high value on achieving equity within the salary structure. Eventually, we agreed to use a salary table as a basis of negotiating (see Figure 2). These salary level values were not considered minimum rates, rather, they served as reference points for determining how much "equity" money a person would receive in addition to an across-the-board factor. Negotiation centered on the amounts to be allocated for each purpose.

Throughout the salary negotiation phase, there was considerable interest on both sides in working toward a three-year contract. In Figure 3 you will note the effects of distributing different amounts

LEVEL VALUE TABLES

Years	Inst/Lect	Asst	Assc	Prof
1	$11,100	$13,600	$16,520	$21,990
2	$11,540	$14,080	$16,940	$22,430
3	$12,000	$14,570	$17,360	$22,880
4	$12,480	$15,080	$17,800	$23,330
5	$12,980	$15,600	$18,240	$23,800
6	$13,300	$16,000	$18,700	$24,280
7		$16,240	$19,160	$24,760
8			$19,640	$25,260
9			$20,130	$25,760
10			$20,640	$26,280

FIGURE 2

FIGURE 3

ANALYSIS OF LATEST COMPENSATION PROPOSALS BY THE BOARD TEAM AND THE AAUP

(AAUP's in parentheses, our analysis)

	1975-76		1976-77		1977-78	
Total Amount Available (needed) for Compensation Increases	$250,000	($350,000)	$160,000	($215,000)	$450,000	($675,000)
Compensation Increase Results:						
All faculty						
1. Ave. dollar increase	$1,009	($1,419)	$597	($745)	$1,502	($2,373)
2. Ave. percent increase	5.75%	(8.07%)	3.22%	(3.94%)	7.84% *	(12.07%)
3. Ave. total compensation	$18,553	($18,908)	$19,150	($19,653)	$20,652	($22,026)
Total Amount Available (needed) for Salary Increases	$188,700	($277,700)	$129,800	($186,500)	$244,500	($383,400)
Salary Increase Elements:						
1. Across-the-board	2.0%	(5.5%)	2.0%	(1.5%)	2.0%	(2.5%)
2. Catch-up factor	0.287	(0.23)	0.134	(0.32)	0.402	(to reach level)
3. One-time merit awards	-0-	(-0-)	-0-	($22,000)	$25,000	($36,000)
4. If old salary is over level	$300	(gets A/B)	$300	(gets A/B)	$300	(gets A/B)
5. Maximum increase	$1,800	(none)	$1,800	(none)	$1,800	(none)
Salary Increase Results: (excluding merit awards)						
A. All faculty						
1. Ave. dollar increase	$793	($1,138)	$486	($615)	$822	($1,301)
2. Ave. percent increase	5.21%	(7.48%)	3.09%	(3.83%)	5.06%	(7.80%)
3. Ave. salary	$15,750	($16,065)	$16,236	($16,681)	$17,058	($17,982)
TOTAL COMPENSATION INCREASE	5.75% (Returning Faculty)	(8.07%)	3.23%	(3.94%)	8.81%	(12.07%)

in accordance with the parameters each side had established at one point in time. Needless to say, it was extremely useful to be able to get relatively short turn-around on our requests for data given modification of the variables. Moreover, it was beneficial to share with the union information in a format such as that which appears in Figure 3.

One compensation factor which had to be considered was the cost of promotion. In Figure 4 you will see how we projected costs for this item. Certain assumptions obviously were made in making these projections, but we were able to partial out a cost element with some degree of certainty since we had already reached tentative agreement on the criteria for promotion. An added benefit of having this type of data was to see what would happen to salary rates for individual faculty members, specific ranks, and departmental units.

Summary

Other illustrations could be cited which would argue for the development of a comprehensive data base. There is no doubt that the scope of bargaining has an impact on data requirements. For example, an institution which has an unstable enrollment picture is likely to experience intense pressure for an elaborate retrenchment or lay-off policy and procedure. Some of you may be familiar with contract provisions which call for maintaining specific faculty-student ratios. One can only hope that such contract language can be justified on other than emotional grounds.

The program planning area has received the least attention thus far in bargaining. If the projections regarding future enrollments hold true, however, job security may well become the priority subject for negotiation.

A 2-YEAR PROJECTION OF ALL FACULTY IN THE BARGAINING UNIT

FISCAL YEAR 75 - 76					FISCAL YEAR 76 - 77			
APPT PERIOD	RANK -YRS	OLD SALARY	TOTAL INC	NEW SALARY	RANK -YRS	OLD SALARY	TOTAL INC	NEW SALARY
THE FISCAL YEAR.				'A' INDICATES AN ADJUSTED VALUE				
09	ASSC-9	$17,500	$ 966	$18,466	*-PROF-1	$18,466	$748	$19,214
09	ASSC-8	$15,800	$1,267	$17,067	*-PROF-1	$17,067	$891	$17,958
09	ASSC-7	$18,600	$ 500A	$19,100	*-PROF-1	$19,100	$683	$19,783
09	ASSC-7	$18,100	$ 550	$18,650	*-PROF-1	$18,650	$729	$19,379
09	ASSC-6	$18,100	$ 500A	$18,600	ASSC-7	$18,600	$395	$18,995

FIGURE 4

Data such as that which can be generated by NCHEMS' Induced Course Load Matrix (ICLM) has significant implications for staff and program planning both in and outside the bargaining arena.

Many of you are familiar with IBM's Business Systems Planning (BSP) process.[2] This approach, which has been adopted by a number of colleges and universities who have undertaken information system studies, is, in my opinion, well suited for management applications in collective bargaining. BSP is a process-oriented activity which stresses planning and information system needs. Bargaining is, in many respects, an art; but one should not overlook the fact that it is an intensely analytical activity as well. Management tools such as BSP can be adapted to meet the unique character of a college or university environment.

At the conclusion of their study on the impact which unions have had on academic governance, Kemerer and Baldridge observe that ". . . administration activities are likely to become more consistent and predictable, for collective bargaining forces administrators to avoid ad hoc decision making."[3] Perhaps one of the salutary benefits of bargaining is that administrators have fewer opportunities to make ad hoc decisions. The development and application of information systems may also add a greater degree of rationality to bargaining itself.

Although bargaining is essentially an adversarial process, administration and faculty representatives must seek accommodations which promote quality as a mutually-agreed-to professional responsibility and goal. If they cannot achieve such accommodations, then, as Professor Brooks noted this morning, further industrialization of the academic enterprise is inevitable.

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PARTICIPATIVE MANAGEMENT:

ITS PLACE IN EFFECTIVELY PLANNING AND ALLOCATING AN INSTITUTION'S DATA PROCESSING RESOURCES

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The theory of participative management can be used to reach effective decisions in planning and allocating resources for data processing. Case studies of the use of participative management in making decisions within a university environment related to data processing installations and management are presented in this paper. Hints for applying this technique are given to assist other educational administrators in the effective allocation of scare institutional resources for data processing.

Today, most educational institutions and organizations are faced with the complexities of managing large amounts of information in a variety of administrative and educational areas. These areas include student information, financial information and resource planning and allocation information, to name but a few. The decision on how to most efficiently and effectively store and process this data is a critical one for educational managers. It is a decision which can determine the effectiveness of the institution in serving its varied constituencies and in wisely using its resources.

Although this decision, the choice of a data processing method, usually involves thousands of dollars, and many choices of alternatives for administrators making the decision, the recent literature of educational management is almost devoid of articles, and information, on how to make this critical choice.

Prior to 1967, there were very few articles on anything related to data processing in the educational environment. Those few treatises which did exist gave little assistance to decision-makers. Between 1967 and 1972 a rash of articles related to the educational uses of computers appeared in journals circulated among all of the facets of the educational community. The landmark Computers on Campus was written during this time; but it, like most other articles and books on educational data processing, gave very little practical information for decision-makers on how to best determine what the data processing needs of his or her institution were and how to best meet these needs. In "So You Are Planning to Buy a Computer!" (Educational Digest, 39:30-2,N'73), Martha and Patrick Rourke briefly list some steps to follow in making a data processing decision. They advise a feasibility study of applications, consideration of software, and exact performance specifications as a means of obtaining the computer best suited to the institutional needs. Their article is the only one which goes that far in assisting the perplexed educational manager in making decisions about data processing installations.

The purpose of this paper is to outline an approach used by two different educational organizations to determine which data processing alternative best suited their needs. Perhaps the experiences endured by these dissimilar organizations might benefit other educational managers who face the same decision. Although both of these decisions were made in institutions of higher education, the methodology can easily be applied to other levels of both private and public education.

The determination of what kind of data processing facility best suited the needs of each of these two educational organizations was completed at separate times by different individuals with diverse backgrounds and perspectives; however, the modi operandi were basically alike. Each used a feasibility study based on the concept of participative management to arrive at a conclusion as to what type of data processing facility would best suit the needs of the organization.

The theory of participative management in a feasibility study is this: as each of the many consumers of a data processing center becomes more involved in the determination of what their data processing needs are, and what facility can best suit those needs, the more interested these people will become in the uses of data processing. Thus, it will be less likely that consumers will feel outside the mainstream of the decision-making process. Because all are given an opportunity to express their ideas concerning needs, and the best manner of meeting those needs, each person can feel that the decision concerning the data processing facility is partially his or her own decision. Therefore, the less likely these people will be to attack the decision and consequently hinder the effectiveness of the facility in meeting user needs. Users at all levels of the organizational structure should be involved. As many a disappointed data processing manager can readily attest, faculty, staff, administrative and/or student resistance to a data processing facility can be the major cause of the failure of an installation.

In College and University Business, Dennis emphasizes the point that staff support and participation is critical to a successful data processing installation; further, he states that the involvement and support of highly placed administrative personnel is essential. Thus, the involvement of major administrative officials of the organization should be an integral segment of the feasibility study.

Applying this theory of participative management to a practical situation lead to the development of a specific plan of action at each of the two separate organizations discussed here. The remainder of this paper will be devoted to a description of each of the two data processing feasibility studies, comparison of the two, and implications of this success or failure for other educational organizations and institutions.

The two educational organizations involved were Millikin University in Decatur, Illinois, and the University of Illinois Foundation, Urbana, Illinois.

Millikin University is a private, church-related residential college offering a wide range of programs at the undergraduate level to approximately

1,500 full time equivalent students. Located in an industrialized, mid-state city of 90,000, Millikin participates in a cooperative advanced level degree program with Eastern Illinois University, Southern Illinois University, the University of Illinois and Sangamon State University. Approximately 200 faculty and staff are employed at Millikin.

The University of Illinois Foundation is a corporation formed under the laws of Illinois and affiliated with the University of Illinois. It serves three functions: 1) to encourage private gifts to the University; 2) to serve as a financial agent of the University when requested to do so by the Board of Trustees of the University, by borrowing funds, purchasing properties, and leasing these properties to the University until such time as the University can purchase the property; and 3) to receive the rights to inventions turned over to it by the University and, in the cases in which these seem to have commercial value, to develop the commercial potential of these patents.

The Foundation has a total staff of 25 people, fund-raisers, administrators, and clerical personnel, on the three campuses of the University of Illinois.

At Millikin, data processing is a function of the Vice-President for Institutional Research. This follows the recommendations of the American Council on Education, the American Education Research Association, and other groups, for the organizational placement of the data processing facility. Thus, the center does not answer administratively to any of its consumers, is not under the direct control of either the administrative or academic areas, and is located in an organizationally neutral area.

To determine what the data processing needs at Millikin were, the Vice-President for Institutional Research, with the assistance of a college-wide committee for data processing, conducted a survey of all the segments of the University community. Each department and unit, academic and administrative, was queried as to what its personnel saw as its data processing needs. (This is an essential part of the theory of participative management.) No department or individual was forced to participate in this needs assessment; consequently some of those offices who are normally users of a data processing facility (like the Registrar) were conspicuous by their absence from the list of those who voiced their data processing needs.

From this survey, a summary needs list was developed which represented the input of only those which chose to participate. These groups would be the departments and individuals who would be expected to be the most likely users of a central data processing facility. Their interest was apparent.

As each unit listed its data processing needs, each was asked to give three estimates of what its costs would be in processing the information: a conservative estimate, or the least possible cost of processing this data; an estimate which would be the normally expected cost for processing; and an estimate of the most it could possibly cost to perform the data processing functions.

Those individuals participating were then asked how they would perceive these needs being met, be that by manual processing, computer, or some other way. Personnel also listed what would be the most optimal configuration for processing their data, no matter what the cost.

All this information was summarized by the Data Processing Committee into lists of needs, and a table of the three cost figures (minimal, normal and maximal) for data processing. From these summaries it was determined that, to meet the data processing needs of the institution, or rather only those needs which individuals who had been willing to participate in the needs assessment study had delineated, a computer facility would be necessary. Because the staff and students participating in the needs assessment survey felt very strongly that a data processing facility should be an in-house facility rather than some sort of service bureau or shared facility, it was determined that a data processing center would have to be located on the Millikin campus.

During this period of time, all known makes or brands of computer hardware available for use in Decatur were investigated by the staff of the office of the Vice-President for Institutional Research. Many brands were rejected because their yearly rental costs were too expensive, or came standard with capabilities in excess of both immediate and foreseeable future needs.

From this research of computer hardware, two brands emerged as those which could cost-effectively meet the needs expressed by the various constituencies at Millikin University. The data processing committee compared and contrasted these two brands in great detail on their ability to meet system specifications.

From the recommendation of the data processing committee, on approval of the president of Millikin, whose final decision the choice of a data processing facility was, a computer was rented and installed in the central building on the Millikin campus, and personnel were hired. This facility has been in operation for three years, and is, by most evaluations by Millikin staff, a successful facility.

Evaluation of the success or failure of the data processing center at Millikin to meet the needs explicitly stated by the many constituent groups of the University is an on-going process. There is almost unanimous agreement among these groups that the center is meeting their needs. This success in meeting the needs of the University is due in large part to the method by which the data processing installation was conceived -- the feasibility study which used participative management as its underlying theory.

Thus, the concept of using participative management in a feasibility study to determine the data processing needs of an educational installation has proved to work well at at least one institution of higher education.

The University of Illinois Foundation had data processing needs which were administrative in nature, as opposed to the combination of both administrative and academic needs of Millikin. Since 1965, the Foundation had been using a batch processed computer tape system to maintain giving records on about 50,000 donors. There was another "system" which maintained accounting records on over 2,000 funds and general accounts. Unhappiness over the ability of these systems to provide information which was useful to management or to fund-raisers had grown to the point that little reliability was placed on any of the donor records.

To evaluate the situation and make recommendations for needed changes, the Foundation hired a management consultant. This consultant used essentially the same methodology to reach a recommendation for the data processing system of the University of Illinois Foundation as did the Vice-President for Institutional Research at Millikin University.

First, all clerical and professional staff members were asked to participate in a survey to determine the needs of the organization and how the staff felt those needs could best be met. Only those staff which were willing to participate were included in the survey. This included all of the fund-raising and administrative staff, but not all of the clerical personnel. Each person was asked to list what the current needs of the Foundation were, in his or her perception, and what additional needs could be foreseen which would be advantageous to the functioning of the organization. Also, staff were asked in what ways the current needs were and were not being met.

This needs survey indicated that there was substantial misunderstanding by Foundation staff about system capabilities. Likewise, data processing personnel did not comprehend the needs perceived by the Foundation staff. Communication between the offices was virtually non-existent.

The use of participative management immediately alleviated this situation. Because both offices were included in discussions about system requisites and capabilities, the communication channels between the two offices were opened to meaningful discussion for the first time in years.

Estimates of the costs of meeting both current and projected needs were obtained for pessimistic, normal and optimistic levels of funding. This was the same method as was used at Millikin University.

Because the University of Illinois Foundation serves the University of Illinois, the chief administrators of the University were also surveyed to determine what management needs the Foundation fulfilled, or should fulfill, for the University, and its related affiliates, like the Alumni Association and the Athletic Association. All these needs were compiled into a listing encompassing the needs expressed not only by Foundation staff but also by University personnel.

This summary of needs was presented to all the Foundation and University of Illinois personnel participating in the survey. Each person was asked his or her ideas on the best method(s) of meeting these requirements. At the same time, all brands and models of computer hardware available in Champaign-Urbana were investigated to determine their ability to meet specifications. Additionally, manual processing and accounting machines were explored to determine the feasibility of those types of systems in meeting the organization's data processing requisites.

From all of the recommended alternatives for data processing, the staff agreed that five possible systems had possibilities for meeting the current requirements. These five alternatives were explored in detail; exact system specifications were developed to evaluate the alternatives. From the staff recommendations regarding these alternatives, then, a computer system with on-line terminal entry and processing of gifts and other account transactions was selected. This system, an on-line, data base system utilizing IMS, has been functioning for one year. Gifts are posted to individual records and receipts mailed to donors within three days of delivery to the office; fund-raisers may obtain hard copy output of individual records at any time. Confidence in and acceptance of the on-line system is at very high levels, in marked contrast to the rather depressing status of data processing two years ago.

Improvements in and evaluation of this system is a continuing process. From all accounts, both University and Foundation personnel are extremely satisfied with the success of the system in meeting organizational needs at this time.

Both of the feasibility studies described above provided an opportunity to observe the usefulness both of the theory of participative management and of feasibility studies in the arena of educational data processing.

It is impossible to generalize from these two studies to all situations in which decisions concerning data processing in an educational environment are required. It is possible, however, to note that, in two very different segments of the educational world, the methodology of using participative management in a feasibility study produced "good" decisions. (A "good" decision is here defined as a decision which has the support of different levels of institutional hierarchy and which produces a data processing situation which meets perceived organizational needs.) Because participative management involves each level of the organization's hierarchy in the decision-making process, individuals are induced to regard the decisions made (to choose a data processing installation) as their own decisions. As it is human nature to support one's own decisions, support by the different levels of organizational hierarchy for the data processing alternative could be said to be predestined.

To insure the continued success of the data processing installation in meeting organizational needs, it is not sufficient to use participative management in needs assessment and installation choice, and then stop. The continued involvement of each level of organizational hierarchy in the continuing evaluation of the system is essential. Without continued involvement by staff, (through the avenue of a user's committee, for example), it is probable that the installation will lose the crucial support of its users and be perceived as not adequately meeting their needs.

An underlying concept of the theory of participative management is open communication between all levels of management. To have the open communication between staff members which existed in the needs assessment stage of planning for data processing eliminated, could produce mistrust among staff and even open hostility toward the data processing personnel and office. In an organization where staff do not continue to participate in the planning, evaluation and management of data processing, lacking cohesiveness and direction, factions are likely to proceed in diverse directions, contributing to upheaval and the eventual failure of the data processing facility. The experiences of the two organizations discussed here support this viewpoint.

Therefore, if planning for data processing is initiated using participative management, continuing operations and evaluation of the data processing facility should also utilize the same management theory.

There are other disadvantages to the use of participative management. This management style requires a much longer time frame to reach decisions because of the involvement of many individuals. Since it is said that time is money, this would imply that using participative management consumes more of an institution's resources, human and monetary, than do other management methods. It can be argued, however, that the benefits derived from participative management more than offset the additional costs in time and money.

The two organizations discussed before are not large; to test the applicability of the participative management theory in educational data processing in large organizations, these techniques were used with the Decatur (Illinois) Public School District. The Decatur Schools serve 20,000 students and employ over 2,000 staff members. To this date, preliminary needs analysis has been made, employing the methodology of participative management in a feasibility study. As a result of that preliminary study, the Decatur Schools have altered their data processing organization to more effectively meet district needs. It is hoped that more complete information regarding the Decatur schools' systems "experiment" will be available soon, so that the experiences of the University of Illinois Foundation and Millikin University in the application and use of the theory of participative management in planning for and managing data processing facilities can be more readily generalizable to other size organizations.

Perhaps this can give other educational administrators a tested methodology to use in increasing the probability of a successful data processing facility. At a time when educational administrators are being held accountable for their decisions and for the wise allocation of scarce resources, any method which would increase the probability of passing this test should be welcome.

STATE FUNDING MECHANISMS FOR HIGHER EDUCATION: A MANDATE FOR INSTITUTIONAL ADOPTION OF INFORMATION SYSTEMS

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To insure institutional and program funding at adequate and equitable levels on a continuing basis, planning and management information systems must be instituted and accorded a high priority by public colleges and universities. Institutions dependent upon the state for appropriated monies must be able to define, support and defend their perception of the educational future in possible opposition to a legislative and/or executive perception or face abdication of increasing amounts of control over their future direction. At issue is an educational versus a fiscal view of higher education.

INTRODUCTION

When the title of this paper was chosen, the intended message was two-fold. First, we believe that many states are adopting funding mechanisms and methods which do say in rather clear terms "Any institution that comes to our door seeking money had better be able to back up the request with hard data." And that hard data is becoming more and more voluminous as the years go by which, in turn, dictates a information system of some type. Second, we didn't intend to insult your intelligence by suggesting that this is the only reason you should institute an information system. Rather, this is only the latest, but probably the strongest, force yet brought to bear and forcing you inexorably in the direction of information systems.

We would like to explore what has brought us to this point and what the meaning for institutions might be - or should we say is already? In a day of ten dollar calculators, electronic watches with extreme accuracy, and mini-computers that can be bought for hundreds of dollars but out-perform the hundred-thousand dollar computers of just a few years ago, it is to the advantage of every institution of higher education as well as executive and legislative offices to obtain the best information available. (We assume here, of course, that the better the information, the better will be the final decision. It is hoped that this is not yet totally unwarranted!!)

IDENTIFICATION OF TRENDS

Perhaps the factor that has captured most of the headlines in the past several years has been that of enrollments. Prior to actually receiving the fall 1976 enrollments, the National Center for Education Statistics estimated that the total college and university enrollment would be virtually identical to that of a year ago. We don't know how each of your states have made out, but Michigan has followed what appears to be the nation-wide trend in reporting a slight decline. While our publicly supported four-year colleges and universities declined about two percent, the publicly supported two-year colleges (those growth colleges of the sixties) declined about five percent. All of this supports the forecasted enrollment developments of many who agree on at least two conclusions: 1) colleges and universities cannot expect to achieve long-range growth through the enrollment of larger numbers of the traditional college-age student in liberal arts programs, and 2) the long-term decline in the birthrate and apparent stabilization in the college attendance rate of 18 to 20 year-olds are central contributing factors that must be considered. For institutional and public planners, enrollment analyses become directional services for adjusting to emerging programs and recruitment needs. To fully appreciate the enrollment patterns, demographic trends, economic participation rates and student interests, higher educational officials must be able to operationalize such information as planning tools.

Declining levels of public financial support for higher education also represents a key trend affecting colleges and universities throughout the United States. Decreased funding levels and executive cuts coupled with rapid growth in the cost of goods and services have mandated tuition and fee increases for most institutions. In November, The Chronicle of Higher Education reported the median tuition raise by state colleges was ten percent over last year's rate. Inflation combined with lagging state appropriations were cited as the causes for the sharp tuition increase borne by students. That same article noted that tuition and fees increased for graduate students even more than for undergraduates, some 15 to 20 percent over the previous year. With student charges and the cost of goods and services doubling during the past ten years coinciding with a decline in the level of public support, an apparent shift in public priorities has surfaced. Students and their families are assuming an increasing portion of the costs of higher education as the states' share declines. This view coupled with an examination of enrollment information protends that fewer students will bear a larger share of the costs. Obviously, the adequacy of the funding levels is related to each state or institution, but such dramatic cost increases raise the question of student access remaining equitable. If a state or institution is committed to a goal of equal access to higher education for all citizens, then confronted with shortfall funding and double digit cost increases without concomitant additions to financial aid,how can access to higher education be maintained?

Another trend appears to be the confusion between governance and management. There needs to be a distinction; they are not the same process. We suspect that this blurring of relationships is one explanation for current financial problems. Governance is that process concerned with basic issues of purpose and policy; management is that process concerned with work performance. Those people responsible for college and university governance have been enlarging their focus to address budget decision which, in the final analysis, relates to specific departmental objectives. What was once the sole property of management of resources has become the focus of discussion of the policymakers. The result has been the raising of the level of decisionmaking to higher and higher levels within the university, or has even moved them out of the university and into the statehouse. The result is protracted among departments, faculty and administration for favorable budgetary decisions for their respective objectives, regardless of the overall budgetary implications. The reasons for this rising level of decisionmaking are doubtless many, but it appears that the major one is the frustration felt by everyone when they try to spread limited resources farther and farther. The belief is that the job will be easier, and the results more equitable, if only they knew just a little bit more or were able to control at a bit finer level than they have in the past. It is obvious to most who take time to step back from this problem to see that the result is a change in the identity of the players, not increased wisdom or a larger amount of funding available for colleges and universities. The basic need at any level, however, still exists, that of planning and coordination for maximum utilization of resources. Greater complexity will continue to force more centralization of decisionmaking unless everyone involved has access to the same information. The difficulty, as in the past, is to avoid program leveling or homogenization and balance between control and autonomy. By adhering to clearly defined levels of administrative responsibility and faculty responsibility, that goal can be achieved.

The impact of collective bargaining and faculty unionization upon higher education is beginning to be felt and appreciated by almost every institutional and agency planner by now. The imposition of collective bargaining agreements have, in general, encouraged the growth of more formal conflict-resolution arrangements within all sectors of higher education. The reliance on formal authority and grievance procedures tends to be greater in organized institutions than in non-unionized institutions. As an outcome of collective bargaining activities, college and university administration of contracting and non-contracting institutions alike are induced to collect and maintain extensive employment information and records for the development of an information base for analytic purposes. State government response to collective bargaining in higher education has tended to support legislation which is increasingly structuring the management of the conflict that is arising. And even if that has not happened, management is being caught in a vise grip of rising demands on one side and stable or decreasing resources on the other.

The trend toward formula funding will be left to a later portion of this paper.

OUR "PUBLICS"

There are many publics to which institutions and the state executive and legislative offices must respond. These factors, too, are helping to push every institution toward increased use of information systems.

The state executive offices and legislatures have two basic functions to perform with respect to the funding of state higher educational institutions. First, is to determine, among an array of many state-level priorities, what portion of state resources can be allocated to higher education. The second function is to devise some mechanism for distributing these resources among institutions.

In the performance of these functions at the state level, institutions must be aware of the many publics to which state agencies, Governors' offices, and legislators are responsive. A single letter from a disgruntled constituent to an influential legislator can sometimes have as much impact on an appropriation as a two-hour presentation by the university president. Other, more organized, lobbying groups can also strongly influence the political process.

In some states, teachers' unions and other organized labor groups are extremely important and can have substantial impact either for or against higher education funding. Business organizations, like state chambers of commerce, have generally been more concerned with revenue and taxation issues. Other citizen or community groups can also influence the course of legislative action. Welfare rights lobbies can have the effect of diverting funds from higher education to social services budgets.

Student organizations have traditionally focused their attention at the campus level, but other university-based groups like faculty associations, professional organizations, and accrediting agencies can develop an impact at the state capitol which may well influence an institution's level of support.

Governors and individual legislators rightly perceive themselves as representing a broader constituency than just the higher education community. There is keen competition among many sectors for a share of limited state resources. As has been seen from recent trends in state support, higher education may be loosing ground in competition with other priorities. The existance of these other publics which can have impact on state funding decisions provides added reason to support specific, objective, and quantative approaches to higher education funding. Providing these kinds of arguments in support of appropriations requests may, and you know they will, require the collection of data never before needed, but which will be necessary to "make your case."

WHERE ARE WE GOING? WHAT DOES IT MEAN?

Change is a fact of life and, in fact, is life. Change will always be with us and is the major support for improved information and planning. When change is known to be coming, the desire is there to make the "best" change possible - the one that will solve the most problems or offer the greatest flexibility in the future. In an earlier report on the "steady state" of education, the discussion is really about the evolving mix of changes that are taking place and must be dealt with. There are actually five areas of change that must be addressed.

First, the introduction of new or improved products is occurring in higher education also. Over the years, higher education has produced extensive credentialism, the associate degree, the external degree and life-long learning as new "products" to serve the needs of the people. While many of these changes have evolved over the years, many of the new changes in direction are taking place in shorter and shorter time periods and some method must be implemented that will allow more rapid evaluation of these changes and provide a method of projecting how each new change might impact on higher education.

Second, new methods of production are evolving. Higher education is responding to a changing society by providing new ways of offering the product needed. It is in this area that technology has been held out as the greatest change-agent since the educational business began.

That such a massive change has not yet taken place - such as completely individualized instruction, home television education for everyone - tends to hide the great changes that have taken place in the last twenty years, and with the advent of mini-computers, a potential explosion of changes may be just around the corner.

Third, the development of new markets. This has probably received the greatest emphasis as the "savior" of the higher education scene. It was, or is, to be the development of life-long learning and the non-traditional students that will provide the numbers of learners in the coming years to off-set the reduced number of traditional college-age students. Whether or not this will come true is to be seen but the need exists to examine these potential groups to determine if higher education is really the answer to their needs.

Fourth, sources of revenues for higher education are a continuing problem area. If new sources of revenue exist, it is not readily apparent and maximum utilization must be made of current sources. In a day and age of reduced growth, if not actual decline in revenue, and when the demands upon those revenues are climbing at fantastic rates, higher education is forced to present a case that is stronger than ever as to why they should get a piece of that pie. Improved utilization of and management of resources within the institution is also an area that needs as much improvement as possible. It is difficult to ask for resources if maximum utilization is not being made for those resources already received.

Fifth, the organization of higher education into more responsive forms is a major area of change. Because of a number of forces at work on higher education - enrollments, part-time students, increased expectations, more liesure time, etc., - new forms of higher education have emerged in the past few years. Consortia have developed to combine the strengths of several institutions, small and specialized institutions have combined for a larger and stronger organization, and branch campuses or learning centers are popping up left and right to meet the needs of the people where they live.

When a close look is taken at each of these five areas, it can be seen that underlying each of them is a demand for more, and more accurate information upon which to make decisions. In one sense, planning and management systems are needed to "keep up with the Jones" since they provide the data to back up the services. They are also needed to enable you to present your version of the "best" future - and where you fit in. That there is no one answer to every problem is a truism but an important one. Each person or organization will look at a problem from their own background and point of view. The one that can best support their argument will have the best chance of convincing the decisionmakers that their way is "the" way to go.

STATE FUNDING MECHANISMS

Perhaps in no other area are changes occurring which are placing so much of a pressure on higher education. In an attempt to build a better mousetrap, states are moving to different and more complex methods to determine what share of state resources higher edication will receive.

About half of the states use some kind of formula mechanism for providing public support to colleges and universities. These formula funding mechanisms rely primarily upon enrollment and historical expenditure data to determine levels of support to be appropriated. There are problems however, associated with the formula approach to funding higher education; it is hoped that the inadequacies of these methods can be changed with the development of additional and new measures of output.

Our state, Michigan, is currently in the process of developing and phasing in (over a three-year period) a formula funding mechanism to appropriate support for public colleges and universities. To address the historical and quantitative inequities contained in the present budgetary method, incremental funding priorities were assigned to other factors in addition to enrollment and expenditure data. The role and service mission of the individual institution is one component of the new funding formula on which appropriated support to colleges and universities is made. Among the elements examined within the role and mission component are the institutions' statements of their role and the focus and scope of its service area in relation to its undergraduate and graduate/professional programs. Another significant component of the new formula approach is the funding consideration it accords to the concept of "peer" institutions. Under this concept, institutions have been designated as research, regional, technical or state college in orientation. This taxonomy helps to insure that like programs in similar institutions will be funded at comparable levels. At present, joint institutional and state agency sub-committees are working to identify and refine other measures which are unique to Michigan higher education.

One of the problems associated with the development and implementation of formula funding mechanisms is slow institutional response in the development of a data base. This operational shortcoming may be mandated to some colleges and universities because of their size and economy of scale. Executive commitment alone can not singularly create an adequate support system for immediate response to formula funding information requirements. Institutions with insufficient data resources or technology must be allotted adjustment time to complete transition responsibilities without the difficulty of being financially penalized for their former method of operation. The potential for inequitable formula generated appropriations stemming from lagging institutional response becomes a legitimate concern when one notes the diverse levels of information and data treatment which exist within higher education. Subsequent formal appropriations to the institution could be affected by the initial lack of required data.

Competition for public funds from the states' programs, institutional segments and emerging priorities have provided strong incentives for states to adopt formula funding mechanisms. Institutional and state budgetary requests must be presented in a form that is understandably justified and accountable or face certain erosion to other public interests which can be presented in such a format. The formula funding method is an approach which can incorporate the current mandates of public finance. Beyond the general public interest, concern for accountability is the issue of inter-institutional competition for state resources. The funding differences which are attributable to historical reasons, personal qualities of college representatives and "flagship" designations cannot be redressed simply by adopting a formula mechanism. However, formula funding doesn't impose barriers to the solving of those issues as long as all of those involved, institutions, state agencies and the legislature and governor, work toward the solving of those problems.

As was previously mentioned, student access can be managed and supported in a manner consistent with state goals and institutional commitments under the guidelines established in a funding formula. Student financial aid programs have to be carefully linked to access goals in any mechanism to prevent the inadvertent exclusion of all but the most affluent student clientele through inflationary and cyclical economic change.

THE NEED FOR PLANNING AND MANAGEMENT INFORMATION SYSTEMS

Knowledge is power. This is a known and accepted statement of fact. What may not be so clear is that data implies knowledge and that data control is the control of power. While the real issue in most discussions or decisions is values - what shall have priority over what - the fight is usually over the data supporting the points of view. The difficulty is that we do not yet have a good handle on how to use data to articulate, express and support our values. A planning and management information system will NOT answer that question for you. It never could nor will it ever be able to do so. But, since the arguments are so often over data, not values (and this is by conscious or unconscious choice more often than not), it behoves institutions of higher education to provide themselves with the best "ammunition" possible.

Accurate and complete (whatever that means) data is useful for three types of activities. First, it is useful in the building and supporting of requests for resources - either financial or human. What better argument can be given to an executive office and legislature at the state level than "we have explored all possibilities, see the attached supporting documentation, and, if you want us to do such-and-so, we will need the following resources."

Second, it is useful for internal resource allocation. This is in some ways an extension of the first use listed earlier, but goes beyond it in the sense that you work with a given-end total and the sum of internal allocations cannot exceed that total. Each department or sub-unit stands the best chance of gaining the most by submitting the most complete documentation.

Third, it is useful in evaluation of the earlier resource allocations. When the initial allocations were made, you said this-and-that, let us now go back and see if those goals have actually been reached or if there could have been a better allocation of the limited resources. There is nothing to make a department more "honest" in its attempt to perform than the knowledge that its own words and promises will be the only criteria used to measure their performance.

The major push at the state level for expanded reporting capability is the desire of the elected officials to withstand accountability questions. Even if decisions are made on a purely political basis, reams of data that support such a decision will make everyone look better and enable legislators to respond to their public that they have done their best to determine "truth" and the decisions they have made were the best possible in the circumstances.

It is becoming more and more apparent that higher educational institutions themselves are no longer immune to "accountability" questions from the general public, much less than from legislatures. There may have been a time when higher education could ask for and receive state dollars with hardly a question asked about what the money was to be used for and what the benefit might be, but that time is long gone. Institution after institution is being forced into the "public eye" to answer hard questions and support their request for continued existance.

Perhaps the most difficult problem in developing and using planning and management information systems is how to integrate the qualitative and subjective measures that higher education abounds in, into the "hard data" requirements of a data system. Because the desire is so great to develop some type of system, we include what can be measured simply because it can be measured. If the item measured relates to the questions asked, it is often coincidental. An example is the student credit hour. We count them, divide by them, multiply by them, and hold them up as the measure of productivity. The problem is that no one has ever seen one of these "credit hour" things and what its relationship is to actual learning is an unknown and, depending upon the course, everchanging thing.

INFORMATION SYSTEMS AND STATE FUNDING MECHANISMS

In an attempt to bring some kind of closure to this paper, we should lastly look at, and summarize, the benefits of a planning and management information system as it relates to state funding mechanisms. The real key to the usefulness of such a system is the answer to the question, "Does it deliver the dollars?"

State governments are concerned with problems of retrenchment in overexpanded areas of instruction, and the relationship of academic programs to the job market. Searching questions are being raised about such previously sacred faculty prerogative as reduced teaching loads for research and public service. The concept of tenure may be seriously in jeopardy in an era of declining enrollments.

Legislative committees are examining educational outcomes other than credit hours generated as a means of assessing the social value of higher education. Although most states have a strong commitment to the support of public higher education with reasonable access to all qualified individuals, there is concern regarding equal opportunities for women and minority groups. This concern is reflected in more data requests on enrollments of women and ethnic minorities and how they fit into present programs.

The rising overall costs of government and increasing priority being given to social services and other programs puts great pressure on higher education to better prove its case for a share of the pie. Institutions resent the added demands for more and yet more data to be collected to satisfy the information demands at the state level. The state, however, must respond to many "publics" other than higher education, and it behooves us to make the best case for higher education that we can.

In the past, it has often happened that a large part of the data request of institutions and provided by them to the executive and legislative offices have not really been used to make fiscal decisions.

Demands from other sectors and limited resources have pushed specific concerns into the background as percentage figures (either up or down) determined overall funding levels. Even worse was the occasional political vote trade-offs made in support or defeat of an issue irregardless of fiscal need. The implementation of a common and useful planning and management information system at each of the institutions and agencies involved should begin to reduce some of the unnecessary reporting. Because of system complexity, only that data that is useful will be requested. Only where all groups can agree on its place in a funding formula, will there be a need to collect a certain piece of data.

The flow of policy decisionmaking does not need to continue its movement to the state capitol. Educational decisions may or may not have fiscal implications, but decisions need not be made on financial considerations alone. Computerized data systems can give everyone access to the same information at the same time and help to return appropriate decisionmaking to its lowest, instead of its highest, level. All of this can be supported with a comprehensive, accurate, and accessible data base beginning at the institutional level.

RATIONALIZING MANAGEMENT INFORMATION SYSTEM COSTS

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This paper examines the proposition that management information systems for colleges and universities are not achieving their original objectives of supporting better management decisions by providing more and better information in a more timely manner. As a consequence, the MIS activity should be reduced in scope, and standardized to achieve lower costs. The resources that are released can better be used to sustain institutional viability.

The basic theses set forth in this paper are:

1. MIS IS A GOOD IDEA, BUT AHEAD OF ITS TIME
2. MIS WAS A SOLUTION PROPOSED FOR A LITTLE UNDERSTOOD PROBLEM
3. UNLIKE BUSINESS, COLLEGES AND UNIVERSITIES ARE NOT TIME-DEPENDENT
4. "BETTER MANAGEMENT" SHOULD NOT BE CONFUSED WITH POLICY DECISIONS
5. MIS WAS A HELP FOR YESTERDAY'S CENTRALIZED PLANNING
6. INFORMATION COLLECTED AND STORED HAS NO VALUE UNLESS USED
7. IT'S NEVER TOO LATE FOR A COMPREHENSIVE ORGANIZATIONAL ANALYSIS
8. STANDARDIZATION OF COMMON OPERATING PROCEDURES ON A NATIONAL BASIS IS ONE ROUTE TO LOWER CAMPUS INFORMATION COSTS
9. RETRENCHMENT WILL BE ORDERLY OR CHAOTIC, BUT IT WILL BE

INTRODUCTION

I would like to believe that I am neutral in what may appear to be an administration-faculty debate over the allocation of resources. As an academic dean, my primary responsibility is for our school of engineering. As a member of the teaching faculty I am reminded daily of the needs of the classroom. For many years I have been involved in planning for the University, and institutional research. Most recently I coordinated the conversion of our central data processing unit from a batch to an on-line system. This paper describes my reasons for believing that at this time, a considerable share of the funds now being spent on data processing and the development of management information systems, can better be utilized in other activities which are more directly related to sustaining institutional viability.

My first involvement with management information systems came in my first post-college job when I participated in a study to determine the feasibility of replacing a McBee Keysort factory payroll system, with an IBM unit record system. We were primarily interested in reducing the cost of payroll preparation. I remember that by reorganizing the procedures, we were able to lower costs, and retain Keysort, which made it unnecessary to obtain new equipment, or retrain payroll clerks. When I first encountered MIS for colleges and universities, the emphasis was on more, better, and more timely information in support of better management decisions. There was no mention of lowering costs. I believe that now is the time to lower costs.

Let me inject that I too, had high hopes for the MIS concept. As a member of the university's planning group, I became enamoured with PPBS, and still am. The procedure is logical, and it provides an excellent forum for the kind of analysis and debate that is appropriate to the academic governing style. But somehow, we, and most other institutions, were never able to adapt this approach to our organization. I too, developed my own 100 variable simulation planning model accommodating only the most fundamental planning data. Dynamic planning, however, providing decision makers with the opportunity to test the impact of planning alternatives, is still foreign to our decision procedures, and has not replaced the traditional approach to budget development--incremental changes to the previous budget.

The observations that follow are my assemssment of what went wrong--why rational decision making hasn't become standard practice in colleges and universities. what we can learn from this, what we should retain from our present experience, and what we could be working towards in light of the current plight of our institutions.

MIS IS A GOOD IDEA BUT AHEAD OF ITS TIME

The report of the 1969 WHICHE seminar on management information systems for colleges and universities summarized the aspirations for MIS and described some of the concerns for the development and use of systems and analytical models:[1]

1. Because of growing complexity, institutions of higher education are becoming more difficult to manage.
2. Better management is the achievement of more desirable ratios between costs and benefits.
3. Management information systems that would provide more, better, and more timely information would assist managers in making better decsions because they would better understand the consequences of alternative courses of action.
4. Because management information systems are costly to develop, there

should be a regional or national coordination of MIS activities to conserve time, effort and money by preventing duplication of development effort.

5. Unless information systems and analytical models are adopted and used, their development is an academic exercise.
6. Unless more money is spent on administration, it is unlikely that it will be improved.

What has happened to these aspirations and plans during the past seven years?

1. Institutions became no less easy to manage, but a whole new set of problems has developed. Expansion has been replaced by retrenchment. Student concern with world social order has been replaced by a concern for finding a personal role in contemporary economic activity. Decreased faculty mobility has intensified the conflict over economic issues. Sustaining institutional viability when there is little freedom of movement, has become the central concern.
2. While we continue to measure costs with greater precision, we have made little progress with measuring benefits and as a consequence, have had to settle for outputs for measuring efficiency.
3. Analytical models have a fascinating attraction, especially in the classroom, but few have successfully moved into the decision making arena.
4. The national coordination of systems development continues. It is probable that the fiscal ability of individual institutions to continue to participate and contribute will be seriously curtailed despite still to be achieved positive goals.
5. The cost effectiveness of MIS for the individual campus is my concern in this paper.

6. Considerably more money has been spent on the administration function in colleges and universities during the past six years. This development should be subjected to analysis to see if there has been a return on that investment and to raise the question, what economies of scale have been achieved.

MIS WAS A SOLUTION PROPOSED FOR A LITTLE UNDERSTOOD PROBLEM

While everyone is in favor of better management, more information was proposed as a solution to the college and university "management problem" without being certain if a lack of information was the problem. In 1969, two approaches were proposed for collecting information:

1. The approach adopted by WICHE was that there should be a clear identification of the problem, an approach to the solution developed, and then an identification of the information required so that the information collection and retrieval costs could be minimized.
2. The second approach was to collect and store all possible information in anticipation of the unforeseeable question.

Considering the first case, we are still collecting information without knowing precisely what is needed because the problems keep changing and we do not know which problems or solutions we will be asked to support. The comprehensive information retrieval approach initially encountered technical problems with data base design, but they were resolved. What is still not known is whether or not the cost of achieving this level of preparedness is justified by the institution's ability to react more quickly.

Without really understanding the decision process, or knowing what information was required, we therefore began to collect and store massive amounts of data because the technology became available and it seemed like a reasonable approach. The search continues for a workable system of governance and related decision making for colleges and universities. MIS arrived before we were ready to make use of it.

UNLIKE BUSINESS, COLLEGES AND UNIVERSITIES ARE NOT TIME-DEPENDENT

There are a number of reasons why MIS will always be less beneficial on campus than in business and industry.

1. There is a pay-off for the time-dependent information in business that can't be realized by colleges and universities. The profit potential of fast inventory turnover, optimum equipment utilization, rapid response to market changes, or fast customer response times, are less critical campus problems. The reservation systems for the airlines can be duplicated for campus registration, but at what cost and for what benefits. We have a tendency to speed up our procedures because we have the technological capability.
2. Business requires centralized planning and coordination of marketing plans, finished goods inventory, production schedules, work-in-process inventory, pruchasing, manpower, and facilities, on an hourly and even minute-by-minute basis. No such rapid dissemination of plans or coordination of activities is required in the most complex multi-campus state systems.
3. Most campuses have not had to reach the data processing operating efficiencies that are expected in business. Not all institutions operate on 24-hour schedules. This has required larger capacity machines, and is nice for big programs and for expansion, but is still a competitor for limited funds.

In summary, information systems that are selected because of fast response times may not be compatable with the campus pace. A student may not want his grade report in 48 hours if the price is fewer periodicals in the library.

"BETTER MANAGEMENT" SHOULD NOT BE CONFUSED WITH POLICY DECISIONS

Defining better management as reaching a more desirable ratio between costs and benefit is a reasonable beginning. The problem is, of course, that we haven't been successful in measuring benefits (see Keller[2]) so we have reverted to measures of output, carefully accumulated costs, and arrived at "efficiencies".

In our serarch for an evaluation of performance, it seems to me that we are confusing efficiency and institutional priorities. Efficiencies can be developed by comparing outputs with some standard of performance. On the other hand, priorities must ultimately be selected by governing boards and administrators, who are then second guessed by taxpayers and tuition paying students who either agree with the priorities selected, or ultimately withdraw their support.

For evaluating organizational unit performance, the most frequently used measure is the "unit cost per student credit hour" for a department, college or even a campus.

$$\frac{\text{Total organizational unit costs}}{\text{Student credit hours taught}} = \text{Cost per student credit hour}$$

While each publication of these tallies of costs per student credit hour normally includes a caveat that they are an imperfect measure, unit costs continue to be widely used--benefits are difficult to identify and measure, unit costs are understood by businessmen, they are easily calculated from readily available data, and more knowledgeable indicies have not come into use.

The next inevitable step is to identify "best managed" departments as those with the lowest unit costs. The higher unit cost departments are then, by definition, the wastrels.

An example will help distinguish efficiency and policy. In the pursuit of highest efficiency, an institution offering the bachelor's degree could offer a nonspecialized degree program of 120 semester hours taught in 24 five-unit courses. Each course would meet once a year, and be offered in an auditorium large enough to accommodate an unlimited enrollment. With only 12 courses taught in the entire college in any one semester, four or six very talented and hardy faculty members could handle the entire instruction program. If, however, this model is considered abnormally efficient, and there is a desire to accommodate wider student interests, or establish greater rapport among students and faculty, then an overt policy decision is made to move away from maximum efficiency and consonant lowest unit costs, towards some alternate model. It is then possible to describe this new policy-derived model as a standard. Optimum teaching loads, section size, elective opportunity for majors, and other determinants of costs are selected as a policy. It is then possible to produce performance indices that compare performance against policy established standards.

The focus of this discussion is that high unit costs in Latin or Greek occur because of limited student interest and not because of wastrel-type decisions made by the chairman of the Latin and Greek department. He probably enrolls all of the students signed up in his courses in a single section; he probably has high faculty teaching loads. Salaries may be the lowest on campus. Chiding the chairman won't reduce the unit costs.

The policy decision is whether or not to offer Greek and Latin, and must be made on the basis of the intrinsic value of those courses to the academic program. Unit costs don't aid in that decision. In a multi-campus activity, where consolidation of programs is possible and students can be redirected to other campuses, the options increase. Still, normal fall course enrollments and the annual record of degrees granted is the only information needed to describe the problem.

MIS WAS A HELP IN YESTERDAY'S CENTRALIZED PLANNING

Centralized planning and formulae budgeting during the past ten years has been given a big assist from management information systems. When rapid expansion was the key problem, it was necessary to develop incremental resource needs so that enrollment projections could be translated into total resource requirements. When the resources actually became available, centralized planning was helpful in establishing the priority of need--where was the tightest pinch, physical facilities, faculty, or the support areas. Once the allocation was made, traditional "stewardship of funds" systems took over to insure that funds were used for the authorized purpose. This may have been the period when the college and university organization most closely approached that of a business organization, displaying the classical management functions of planning organizing, staffing, directing and controlling--the top down mode. Because of growth, there were nearly enough resources for everyone--including funds to support the development of MIS in the quest for "better management". Now that the situation has reversed, there are no longer enough resources for everyone, and the more nebulous problem of institutional viability is being faced rather than additional square feet of chemistry laboratories. The same system will not be equally effective. Growth and expansion requires central planning and coordination. Viability requires grass roots innovation, and this will not eminate from traditional finance deominated centralized planning.

One of the critical tests of centralized planning is whether or not the plans are ever implemented. It appears that if a plan (not just a budget) is put together by a central group without conflict or extended debate by the academic community, it will be difficult to implement the plan because of resistance or just plain inertia. The resistance will be created by those who didn't participate in the centralized planning but are expected to implement it. On the other hand, participative planning is time consuming and tension laden but has a greater chance for implementation because much of the conflict was resolved in the planning.

The search for viability must involve the entire academic community because all will be effected. It is a time for a re-ordering of priorities, and the slimming of many activities which grew when there were different institutional objectives. Today's planning concern must be how to maintain institutional viability as resources are diminished because of decreasing enrollment, inflation, and rising costs of plant operation. Planning must now focus on encouraging those programs that contribute to sustained institutional viability, and developing new programs while at the same time developing a set of retrenchment priorities to make available the necessary resources.

There does not appear to be a need for more information from a more sophisticated management information systems to help with this new planning. Hayes reported the major information items used by the staff for the Oklahoma State Regents for Higher Education in considering alternate retrenchment strategies anticipating that some institutions will lose one-third of their enrollment in the next seven years:[3]

Institutional enrollment
Institutional enrollment change
Per capita costs
Student-faculty ratios
Number of volumes in the library
Average faculty salaries

Tenure status of faculty

Instructional space per capita

Comprehensiveness of instructional programs

Instructional expenditures

All of this information could be accumulated manually. This list suggests that if long range planning is not taking place in colleges and universities, it is for reasons other than a lack of information.

INFORMATION COLLECTED AND STORED HAS NO VALUE UNLESS USED

In his discussion of the uses of institutional data, Service describes an institutional systems hierarchy:[4]

1) AN OPERATIONAL DATA SYSTEM collects and maintains basic data on institutional transactions and activities
2) A MANAGEMENT INFORMATION SYSTEM integrates and transforms operational data into useful information
3) A PLANNING AND MANAGEMENT SYSTEM supports analysis and understanding of future directions

It will be proposed in the next section that a comprehensive organizational analysis should be undertaken to match current institutional activities with current institutional objectives. One of the goals of this analysis would be to carefully distinguish among these three information systems.

The operational data system should be analyzed with the goal of achieving lowest possible costs. The traditional question in procedures analysis would be asked: is the activity necessary, can it be combined with another, can a lower cost sequence be selected, and finally, is there a less expensive way to do the activity? This analysis will help match institutional size and complexity with the extent of systems sophistication. Smaller institutions may find a manual system adequate. When lower costs of clerical operations can be achieved through automation, then a move to an electronic system becomes justifiable. Larger institutions and state systems can justify the largest installation that provides them with the lowest costs and which are commensurate with external information requirements. Considering just this operation level, none of the system should be justified on the basis that it is in support of better management decisions. Leave this for the next higher level.

Analysis of the next level in the system's hierarchy, management information, requires a similar procedure. In addition to identifying "the integration and transformation of the operational data into useful information", the major question to be answered is who is using the information being produced, and what value is this to the institution? With the current financial stress, what is the resource priority of that information use? It is necessary to distinguish between "getting ready" and beneficial applications. For example, consider an alumni-development office information system. The most sophisticated system would be capable of retrieving from a file containing exhaustive information about each alumnus. As a consequence, it might be possible to select an ideal menu for an alumni chapter luncheon based on the recorded preference of the attendees for meat, fish, or fowl. If this kind of information is truly effective in developing stronger alumni support, then the exhaustive nature of the files may be reasonable. If on the other hand, the files are not kept current, or are queried infrequently, or the alumni activity is stagnant, then this MIS application may be just another monument to the wonders of technology.

I have already discussed the third level of information systems at some length. An organizational analysis will confirm that it is increasingly difficult to evectively utilize MIS at the planning level because of the changing nature of the problems confronting higher education.

IT'S NEVER TOO LATE FOR A COMPREHENSIVE ORGANIZATIONAL ANALYSIS

The attitude I am seeking to convey is that MIS was prematurely introduced to an organizational setting that is unable to profit from its potential. There has not been the level of demand for information that was anticipated, and much of what has been made available is not being effectively used. Therefore, those parts of the hierarchy of information systems that are not making a contribution, should be discontinued. A comprehensive organizational analysis is proposed as a mechanism for identifying the useful vs. the superfluous. A periodic organizational analysis is necessary because institutional objectives are continually changing and a knowledge of what is being done is an essential first step in meeting new objectives.

Four elements of the organization need to be considered:

1. Structure - The way the whole organization is developed from parts, and the interaction of those parts
2. Content - The way the work is done and how. The analysis to include each operation and potential to change or simplify
3. Communication - The collection and retrieval of data and information
4. Control - The making of plans, setting of objectives, and monitoring of performance

What are the kinds of questions we should ask?

1) What is the cost/benefit of a total institutional integration of systems? This question is particularly pertinent as the costs of mini-computers declines, and distributive systems become more sophisticated.

2) What reports can be generated on a one-time basis, from basic data without developing comprehensive files on a "be ready to answer the question" basis. If the costs of providing instantaneous answers are known to the decision makers, do they still want stand-by systems.

3) Who is reading what reports, what do they do with their new information, and what value does this have for the operation of the institution?
4) What office or department activities are seasonal with peaks and valleys. Which activities might be combined with out-of-phase activities providing a reasonable year around leveling?
5) Which courses can be offered in alternate years to gain increased section sizes and not disrupt essential course sequencing?
6) Can the costs of retaining small instructional sections, to gain greater student-faculty rapport, be displayed to see if this still remains a high priority considering today's fiscal climate?
7) What new kinds of activities are waiting to be initiated--curricular, faculty development, services, if resources can be freed for their support.
8) Given campus facilities designed when energy was cheap, what steps can be taken to accommodate the reality of imported oil for many decades?
9) If extra-curricular activities need to be curtailed, what are the current student priorities?
10) How can the information from an organizational analysis best be introduced into the decision structure.

Most colleges and universities do not look at their procedures on a comprehensive basis. For example, when systems are jointly developed by the data processing manager and a user, rarely does a third person participate as an institutional observer to insure that both functions don't sub-optimize, that is, to be certain that in order to make the user's job easier, and perhaps to test under-utilized data processing system capacity, a more elaborate system evolves than is really necessary if all of the needs of the institution *are considered*.

This kind of comprehensive analysis is especially critical for data processing and management information systems at this time. There is a high probability of over-reaction. It is possible that in the attempt to share reduced resources, the present computer based systems will be severely curtailed and replaced by manual systems, many of which still exist as backup. Some essential information can be obtained at the lowest cost only by automation. We need an analysis to find out.

STANDARDIZATION OF COMMON OPERATING PROCEDURES ON A NATIONAL BASIS IS ONE ROUTE TO LOWER CAMPUS INFORMATION COSTS

Several years ago we faced the prospect of a total data processing systems collapse at Santa Clara. In one week we faced all of the problems that other installations face in a lifetime. The data base being developed over several years had not become operative, and there had been three hardware configurations in five years. Most programs were being emulated. There was little documentation of programs which had been written in at least five languages. Programmers became operators when it was necessary to run because they never let go. Because of higher salaries in industry, people came and went before anyone knew their last names. And of course, the girl who wrote and ran the payroll program was pregnant and going to deliver before the next payroll. In quiet desperation, we moved payroll to a bank that produces four hundred thousand payroll checks each week. There was some internal resistance because we could no longer offer a personalized, catch-up service to those who were late in submitting payroll vouchers. Not all of the reports we had formerly produced were available from the bank. They could not "customize" their service for each of thousands of clients. We adjusted, and our payroll costs are one-tenth of what they were when we did it inhouse. While we eventually got our house in order, the world's largest bank is still doing our payroll.

While some faculty duplicate class notes enroute to a published text, most of us use nationally produced texts. If you are a fortunate author, your text may be adopted by hundreds of schools. We see no need to customize our textbooks to the needs of our students. Yet throughout the land, we have hundreds of customized admissions, registration, grade reporting, financial aids, alumni, development, and financial reporting systems tailored to meet the changing needs and desires of the individuals responsible for those functions, at a particular time. This probably is a major reason why colleges and universities have not achieved the economies of scale that were anticipated when the enrollments climbed in the fifties and sixties.

This group, the College and University Systems Exchange, was of course, organized to swap software and reduce programming costs. Yet even here I have heard the comment--it's just about as easy to start from scratch, as it is to rewrite someone else's program to meet our needs. I am not certain just how much CAUSE can do to promote the use of standardized procedures and systems. Perhaps this must first start with pressures on campuses to reduce costs. I am certain, however, that as software firms and computer manufacturers seek to expand their services, there will be more turn-key packages which will allow colleges and universities to lower the costs of their services.

RETRENCHMENT WILL BE ORDERLY OR CHAOTIC, BUT IT WILL BE

It may be that colleges and universities will be unable to react in time to minimize the shock of retrenchment. Perhaps the shock must come first. It is my thesis that nearly all institutions will need to back away from their peak activities to absorb the decrease in post secondary education enrollments. Most have already felt the sting of no growth, and the lack of new money for new programs. Inflation, of course, continues to eat away the real-money support of existing programs.

I have proposed that we do a systematic and comprehensive review of all of our current activities for the purpose of identifying the essential from the less essential. Our goal should be to sustain a viable institution even though it must be at a somewhat lower activity profile. This is a most difficult task--establishing the priorities by which we move from our present to our alternate position. MIS is one of the most visible activities, and will be subject to review because it is one of the most expensive newcomers to our scene. I do not believe it can hide behind the screen of "better management" without defending its achievements. Faculty are suspicious of all overhead activities. Their suspicions are confirmed by such studies as that reported by Buchen.[5] In his study of three schools of considerably different sizes, when enrollment dropped 2% in 1974-75, faculty number decreased 9%, and staff support numbers dropped 8%. On the other hand, supervisory or managerial personnel increased 9%. This latter group had increased six fold between 1960 and 1975, while the students and faculty had increased three fold. The plea to increase financial support of management has evidently been heard. Information has yet to be collected on the impact of that decision.

The work that needs to be done, however, cannot be stymied by a we-they, administration-faculty debate. To be successful the analysis must be a community activity. There must be an internal agreement on priorities or they will be set from outside. Since institutional viability is primarily faculty viability, it will be necessary for the faculty to arrive at rational priorities for its own activities, or anticipate that others do it for them. Those services which are found to be essential to the achievement of the primary programs must be identified so that in the event of across-the-board reductions in response to fiscal crises, control will not be arbitrarily applied without planning.

Planning is supposed to precede control as a management function, but control is much easier to initiate.

To the top administration is left the onerous task of preventing sub-optimization--the tendency of all of us to want the largest allocation of resources as possible, for our own activity so that we can be certian that our activity is outstanding and brings us deserved recognition. Few of us are able to objectively view ourselves and our activities in a comprehensive institutional context. That is why we must be subjected to an institutional wide analysis and review.

Finally, I have probably been over-critical of the money spent to introduce MIS to college and university management because I have never been convinced that information is the constraint. The problem is organizational because of the peculiar nature of the university and the relationship of its constituents. Many years ago Tickton described a fairly simple method for making ten-year fiscal projections, as the basis for long range planning.[6] The necessary information could be assembled in a couple of days from the annual reports of the business office and the registrar. Ten year extrapolations were not difficult, restricted as we were to using an abacus or slide rule. For the next few years, no director of development would be caught in a meeting without his Tickton charts. Yet few institutions kept their charts up-to-date.

Many still restrict planning to cash flow budget considerations. The lack of planning is not because of a lack of information. It is lack of appreciation of its value. When that becomes evident, it will be time to look again at MIS for colleges and universities.

FOOTNOTES

[1] Minter, John and Lawrence, Ben, Editors, *Management Information Systems: Their Development and Use in the Administration of Higher Education* (Boulder, Colorado: Western Interstate Commission for Higher Education, 1969).

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[3] Hayes, Larry K., *Prelimianry State Level Planning for Higher Education Retrenchment*, Proceedings of the 1976 Association for Institutional Research, National Conference, (Tallahassee, Florida, 1976), p. 166.

[4] Service, Allan L., *Planning and Management Uses of Institutional Data: Examples, Issues and Plans*, ibid., p. 143.

[5] Buchen, Irving H., *Managerial Growth in Higher Education: Is the Tail Wagging the Dog?*, ibid., p. 27.

[6] Tickton, Sidney G., *Financing Higher Education 1969-70*, McGraw-Hill Publishers, 1959, p. 138.

INFORMATION SYSTEMS: CORNERSTONE OF A SUCCESSFUL STATEWIDE PLANNING PROCESS

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This paper presents a review of the innovative planning process implemented by the South Carolina system of two-year colleges. State-level data bases, computer models, and analytic procedures associated with the planning process are described, including an occupational demand/supply model, a financial information system, a student flow model, a facilities management system, and a student follow-up system.

Information Systems: Cornerstone of a Successful Statewide Planning Process

Introduction

The South Carolina Technical and Comprehensive Education System (TEC) provides comprehensive, public, two-year postsecondary educational opportunity to the citizens in all regions of the state. The system is dedicated to promoting economic development and meeting postsecondary vocational, technical and occupational education needs by minimizing educational barriers through an open-door admissions policy.

Since its inception in 1962, the TEC System has grown from two institutions and less than 1200 students to sixteen institutions serving 113,000 South Carolina citizens in 1976. Currently over 150 programs of instruction offering either a one-year diploma or two-year degree are available in the TEC System. These programs involve over 4000 different courses which are taught by 2600 fulltime faculty. In FY-77, approximately $56 million is projected to be expended by the TEC System.

As the TEC System grew, so did the need for information by its central administration. This need led to the evolution of a Systemwide Management Information System. It was not until 1973 when a statewide planning process was implemented that the potential and full effect of the MIS began to be realized.

Origin of the TEC MIS: 1970-1973

A minimum amount of reporting to the central office was required of the TEC institutions in the beginning years. Enrollment summaries and payroll information were the primary requirements. Such reporting was accomplished through use of manual forms. Institutional information needs were generally met through internal sources of data, collected and maintained manually; little information flow resulted from the central office to the institutions.

A few TEC institutions, because of instructional programs in data processing, did have access to small computers. Although these institutions began to automate a few administrative functions, computers in the TEC System were used primarily for instruction.

In 1970, the TEC System and the South Carolina Department of Education pooled their dollar resources and established the Educational Data Center. An RCA Spectra 70/55 G was purchased and the center staffed to provide technical support to both agencies and their constituencies. TEC's concern and primary reason for investing in the center was to provide an expanded and more appropriate data processing curriculum to its students. Terminals placed in five of the larger TEC institutions allowed students access to a third generation computer and the high-level computer languages required by industry.

A study by an outside consulting firm in 1972 concluded that the TEC System was not benefitting from the Educational Data Center in proportion to its investment. Moreover, the study pointed to an increasing need for management data, both at the state level and the local level, and suggested that steps be taken to develop and implement a management information system. The decision was then made to develop a pilot student records system on the Spectra 70/55. Five institutions volunteered for the experiment. A consultant and a programmer/analyst were hired to design and develop the student records system. However, because of the central administration's desire to immediately obtain expanded student data, less than six months were allowed to design, develop and implement the pilot system. Consequently several short cuts were taken. The developers adopted, as best they could, an existing student records system used by one of the TEC institutions on a small scale (IBM 1620) computer. This design plus the lack of an adequate terminal handler on the Spectra, led to a centralized batch system for student records, with institutions sending their keypunched data to Columbia by bus or United Parcel Service and receiving output by the same mode.

As one might expect, the pilot student records system had its problems. Punched cards/printouts were lost in transit, mispunched data took from five to seven days to correct, turnaround time on reports was unmanageable. Moreover, the student records system was intended to supplant institutional recordkeeping; instead, it required the institutions to maintain a duplicate, manual system to meet institutional information needs. However, quarter by quarter improvements were made in the system until it was, in a small way, contributing to the administration of the TEC System and each pilot institution.

In 1973, in an effort to expand the design of MIS to include more than a pilot student records system, two additional analysts/programmers were hired to enlarge the MIS to include all institutions and provide information not only on students, but on finances, courses, faculty and facilities. Again, an unrealistic development phase (four months) was imposed upon the analysts. Once again development shortcuts were used--very little documentation was developed, programs were written in whatever language got the job done the quickest, very little user orientation was included, system development, testing and implementation occurred simultaneously. However, the system designed contained a fairly comprehensive data base, at least from the statelevel. This comprehensive data base would prove invaluable to further development of the MIS in later years.

The TEC MIS Comes of Age: 1973-1976

The usefulness of the TEC MIS as provider of management information became apparent in 1973 when a commitment was made by the State Board to implement a comprehensive planning process throughout the TEC System. As part of the reorganization of the state central office, a Division of Planning and Evaluation was established. The Division became responsible for the long-range planning, institutional/system research studies, and reporting of management information for the TEC System. It was through the efforts of this Division and its Director that the MIS was refined and with the additional components became the foundation of the statewide planning process.

The comprehensive statewide planning approach adopted by the TEC System recognized the complimentary functions that exists between the institutional planning and statelevel planning. The function of each institution is to produce educational "outputs" (trained students) to meet identified occupational needs. The purpose of the state agency is to support and coordinate the function of the institutions. Plans developed annually by institutions produced measurable objectives at the program level to meet needs identified within local service areas. These annual objectives were consistent with the philosophy and goals of the statewide system. A plan was also developed annually by the central office staff, describing the statewide programs necessary to support the annual planning cycle at each institution and to coordinate the implementation of all plans throughout the system. The overall State TEC System Five-Year Plan, together with the sixteen plans developed annually by the institutions represented the total statewide planning effort in any given year within an ongoing five-year planning cycle.

Six major components of a comprehensive planning process were defined by the TEC Planning System as:

1- clarification of goals and objectives;
2- assessment of the environomental impact upon the sytem/institution;
3- determination of priorities of objectives;
4- development of programs of action to meet stated objectives;
5- allocation of resources to fulfill programs of action;
6- evaluation of the effectiveness of the programs of action in meeting objectives.

The TEC System MIS became an important source of information (both at the state and local level) for several of these components. In some cases manipulation of data existing in the MIS satisfied state and local planning needs; in other cases however, the data base was expanded and pertinent models were developed.

The assessment of environmental impact upon postsecondary education and the formation of environmental assumptions which might affect the TEC System is an important component of the planning process. It is within limitations imposed by these environmental assumptions that institutional objectives and programs of action are developed. The environmental assumptions cover such areas as economic conditions, government priorities and manpower demand. One tool developed to assist in establishing assumptions on manpower demand is the Occupational Information System, a manpower demand/supply model. This model was developed as part of the TEC System MIS, in conjunction with the South Carolina Employment Security Commission. The purpose of the model is to provide educational planners at all levels with five-year projections of manpower supply and demand in educational terms. A brief, layman's description of this model is contained in Appendix I. The statistical projections from the Occupational Information System coupled with data obtained from industrial surveys conducted by the institutions, provide a fairly comprehensive picture of future employment needs and the demand to be expected for graduates of training programs.

Another important area of environmental assumptions concerns demographic characteristics. The TEC System generally relies upon other state agencies to provide this type of information, with the exception of enrollment projections. The central office of the TEC System, using data from the MIS and from other state agencies, has developed an enrollment projection model to project future enrollments, by institution and by program. The model is based on a trend analysis technique using three population factors and one economic factor. A brief description of the enrollment projection model is contained in Appendix II. The information from the enrollment projection model, augmented by institutional needs analysis, provides estimates which serve as the basis for setting future program objectives and creating future budgets.

The statewide MIS also provides some important input into the component of resources allocation to fulfill programs of action. It is only through proper allocation of resources that institutions (and the state) can implement programs of action and meet stated objectives. Quarterly and annual enrollment reports prepared by the central office provide institutional administrators an indication of how well their institutions are meeting program enrollment objectives (enrollment projections) upon which state allocations are based. Administrators, by reviewing their institution's ability to meet or exceed program objectives (enrollment projections), can better allocate resources to different programs. Appendix III provides examples of the enrollment reports generated through the MIS.

One important resource often overlooked in resource allocation is facilities. Classroom, laboratory and office space all contribute to the success of an educational program. Space utilization reports provide an indication of how well this resource is being used and documents an institution's need for additional facilities. Through the TEC MIS, quarterly utilization reports are produced for each institution. These reports, combined with enrollment projections, provide the basis for determining future need for facilities. Appendix IV provides examples of the Facility Utilization reports.

Financial analyses comprise one of the most important aspects of resource allocations. The TEC MIS is currently in the midst of developing a financial information component. Besides monthly financial statements to be provided to each institution this component will also provide a significant portion of the input into a cost allocation model similar to the NCHEMS Costing and Data Management System. This model will provide administrators with an analysis of how different costs are allocated to programs at their institution, as well as how costs are allocated to programs systemwide.

During the three years in which the TEC Planning Process was being implemented, the mode of data processing activities did not change significantly. The Spectra 70/55 was still being used primarily as a batch-mode machine. Data/reports continued to be shipped by United Parcel Service. The MIS, while an important management tool in the day-to-day operations of the central office, did not provide the same benefit to institutional administrators. However, because of each institution's involvement in the planning process and an increasing need for information available through MIS, activities were undertaken to improve the MIS function and make it more responsive to the needs of the institutions. Programs and program specifications were rewritten to incorporate identified needs. Numerous user seminars were held to discuss the possible uses of the MIS and to identify ways to improve the system. A catalog of proposed reports was prepared with a chronology of their development. User manuals were written for the MIS and the Student Records System.

It was during this time that institutional personnel became aware of the potential management tool that the MIS could be for them. Consequently greater institutional use was made of the MIS data, within the limits imposed by the equipment.

TEC MIS: 1976 -

For the past two fiscal years the TEC System, like many other state systems, has been forced to operate under fiscal restraints. There has been no substantive increase in institutional budgets; in fact, inflation has caused the real dollar value of the budgets to decline. At the same time the system has suffered from lack of fiscal growth, it has been beset by political problems. Disagreement as to the degree of governing power that should reside with the State Board resulted in a modification of the State Board's enabling legislation. The statelevel leadership has changed. The planning focus is no longer as comprehensive as it once was.

The MIS, however, continues to expand its services and improve the efficiency of operation. A year-long computer services study pointed, again, to the immediate need for on-line administrative terminals in the sixteen institutions and additional core at the central computer. The study recommended that TEC negotiate a contract with another state agency, the Division of General Services, to utilize its IBM 360/65. This computer configuration would provide the on-line capability so badly needed by the MIS, as well as adequate core for future development. The contract was accepted in June 1975. The Spectra 70/55 was retained for batch processing work. Mohawk Model 2300 RJE was selected as the terminal to be used with the system. Six institutions currently have instructional terminals installed; the administrative terminals will be installed over the next nine months. In addition, a data base management system and report writer have been purchased and installed in order to facilitate institutional use of the MIS data bases. The TEC System MIS with the development of an institutional on-line-capability has finally reached the stage where it will become an important management and planning tool for the entire TEC System.

Conclusion

It appears that several important lessons can be learned from the TEC experience in developing an MIS.

1. An understanding leadership is a necessity. Not only is it important that the leadership of an institution understand the potential of an MIS, but they must also understand the cost of such a system, both in terms of time needed to develop such a system and the time needed to effectively involve the institution's users. Moreover, an initial show of full commitment to an MIS by the leadership tends to encourage cooperation by other users.

2. Political and fiscal considerations must be well understood. Both factors have a significant bearing on the commitment given to a statewide MIS, the mode of development and the mode of operation.
3. The MIS should be visualized as the major support component of a planning/management system. Once the design of the planning/management system is understood the MIS can be developed to effectively meet the data/analysis/projection requirements of that system. Lacking the perspective of a management/planning system, the MIS would develop as a random accumulation of data, programs, and reports which only respond, in an inefficient manner, to immediate needs for information.

APPENDIX I

OCCUPATIONAL INFORMATION SYSTEM

The purpose of the Occupational Information System (OIS) is to provide educational planners and administrators at all levels with 5-year projections of manpower supply and demand in educational terms (training programs).

Presently, OIS produces eleven (11) reports published in May of each year. There is one statewide report, showing manpower supply, demand, and net demand for each occupation on a statewide basis. Additionally, there are ten (10) sub-state area reports showing manpower supply, demand, and net demand for each occupation in that sub-state area.

OIS consists of three components; (1) Manpower Supply, (2) Manpower Demand, and (3) Net Demand (demand minus supply) projected for the 5-years following the publication date of the report.

The Manpower Supply Component of OIS is composed of all graduates of training programs from the training institutions of the state. Each year, the Manpower Supply data base is updated to include the present year's graduates, and new projections of supply are made for the state, and each of the ten sub-state areas. The Supply Component consists of data gathered from the following sources:

Vocational Education institutions, Technical Education institutions, private vocational and technical institutions, and federal manpower training institutions (WIN, CEP, JOBS, MDTA, CETA, etc.). Data showing the number of graduates in each training program from each of these sources is collected each year by the OIS staff and added to the data base. Projections of anticipated manpower supply for the next five years are then made for each training program from these institutional sources.

The Demand Component of OIS consists of the total estimated demand for workers in each occupation for the state and for each of the ten sub-state areas. These demand projections are obtained annually in February from the South Carolina Employment Security Commission. In order to make these projections, every employer in the state who has one or more employees and is covered by unemployment insurance legislation (about 80-85 percent of workers in the wage and salary sector of the state's economy) is surveyed at least once every three years. In those industries undergoing rapid technological growth, the survey is conducted more often. Data concerning employment in each industry obtained through these industrial surveys is added to the data base, and in February of each year, new sets of projections of manpower demand for each occupation for the state and each sub-state area are produced and transmitted to the OIS staff.

After projections of demand for each occupation, and estimated supply for those occupations have been made, all occupations with similar characteristics are grouped (e.g. all types of welders would be grouped together, all types of carpenters would be grouped together, etc.). This process is called "clustering occupations."

Likewise, all training programs offered commonly by the various institutions are grouped together. This process is call "clustering programs."

Clustering is necessary because a graduate of a welding program, for example, could potentially enter many different welding occupations (e.g. TIG welder, ARC welder, GAS welder, etc.).

Following the clustering of occupations and training programs, the resulting supply clusters are subtracted from the corresponding demand clusters giving "net demand" for each cluster of occupations. These "net demand" calculations are performed for the state, and each sub-state area, for each year that projections of supply and demand are made.

The result of this effort is a series of eleven reports (statewide, and ten sub-state areas) showing net manpower demand for five future years for each occupational cluster.

Since these net demand projections are made at sub-state level and many sub-state areas correspond to TEC Center Service Areas, these reports provide a valuable tool for planning task forces as they strive to identify the occupational needs of their service areas. Furthermore, since all data bases are updated every year, trends in employment for the state and any sub-state area can be identified.

APPENDIX II

Enrollment Projections

Based on the premise that past program enrollments were related to past needs existing in the service area, future enrollments projected from such data can be considered a point of departure for analyzing future needs. Statistical trend analysis, however, provides only a conservative estimate of future enrollments in the State TEC System. The statistical procedure assumes that characteristics present in the historical data will be the same in the future. It also assumes the effect of the environment in the future will be the same as in the past. Since the sixteen institutions in the State TEC System are rapidly broadening their scope and becoming more comprehensive by offering programs to meet a greater array of needs, it can be assumed that future enrollments will exceed the conservative enrollments projected statistically. Augmenting the statistical projections through the detailed needs analysis and status analysis procedures described in Part V produces more realistic estimates of future enrollments. These estimates then serve as the basis for setting future program objectives and creating future budgets.

In order to develop a defensible and feasible enrollment projection methodology for the State TEC System, central office staff researched the different techniques used by more than forty two-year systems as well as the professional literature on enrollment projection methodology. They concluded that a statistical technique utilizing historical enrollment data and three population factors could be used to project enrollments for TEC institutions. The statistical technique was validated by nationally known consultants and by staff of the South Carolina Commission on Higher Education.

The statistical technique utilizes an institution's historical enrollment data from 1965 to last year, the population between 16 and 64 years of that institution's service area from 1965 to last year, the population completing high school in service area form 1965 to last year, and the population entering college from the service area from 1965 to last year. Using these four sets of data a prediction equation reflects the historical interrelatedness of the four sets of data. The statistical process by which the equation is derived also indicates how good each population factor is as a predictor. When a prediction equation is derived the enrollment projection is made by substituting into the equation, projected data describing the population between 16 and 64 years from present to 1980, the population completing high school from present to 1980, and the population entering college from present to 1980. Again, the three population projections relate to the institution's service area. After substituting each year's three population projections into the equation, the equation is solved for that year's projected institutional enrollment.

The projection methodology uses multiple regression to make an estimate of unduplicated headcount enrollment without regard to future programs. It then applies ratio methodology to derive the desired parameters (credit hours, FTE, etc.) from the unduplicated headcount estimates already developed. The methodology provides statistical projections of headcount, contact hours, credit hours, FTE, and CEU's for each program at each institution for any year selected in the future.

MIS BUDGETING SYSTEM: ENROLLMENT BY HEGIS DISCIPLINE

DATE: 06/28/78 PAGE: 2

CENTRAL TRIDENT TECH. COLLEGE - NORTH CAMPUS

HEGIS DISCIPLINE CODE	NAME	QUARTER	QUARTERLY CONTACT HOURS	QUARTERLY CREDIT/CEU	QUARTERLY F.T.E.	NO. OF STUDENTS	CUMULATIVE TO DATE CONTACT HOURS	CUMULATIVE TO DATE CREDIT/CEU	CUMULATIVE TO DATE F.T.E.
0421	ENTOMOLOGY	FALL	7,656.0	464.0	30.9	66	7,656.0	464.0	10.3
0421	ENTOMOLOGY	WINTER	0.0	0.0	0.0	0	7,656.0	464.0	10.3
0421	ENTOMOLOGY	SPRING	0.0	0.0	0.0	0	7,656.0	464.0	10.3
0501	BUSINESS AND COMMERCE, GENERAL	SUMMER	6,638.5	467.5	31.2	102	6,638.5	467.5	31.2
0501	BUSINESS AND COMMERCE, GENERAL	FALL	5,445.0	495.0	33.0	109	12,083.5	962.5	21.4
0501	BUSINESS AND COMMERCE, GENERAL	WINTER	6,732.0	612.0	40.8	135	18,815.5	1,574.5	35.0
0501	BUSINESS AND COMMERCE, GENERAL	SPRING	7,293.0	541.0	36.1	115	26,108.5	2,115.5	47.0
0502	ACCOUNTING	SUMMER	12,771.0	700.5	46.7	124	12,771.0	700.5	46.7
0502	ACCOUNTING	FALL	23,149.5	1,311.0	87.4	231	35,920.5	2,011.5	44.7
0502	ACCOUNTING	WINTER	26,136.0	1,593.0	106.2	297	62,056.5	3,604.5	80.1
0502	ACCOUNTING	SPRING	11,550.0	835.5	55.7	145	73,606.5	4,440.0	98.7
0504	BANKING AND FINANCE	SUMMER	99.0	4.5	0.3	1	99.0	4.5	0.3
0504	BANKING AND FINANCE	FALL	742.5	54.0	3.6	12	841.5	58.5	1.3
0504	BANKING AND FINANCE	WINTER	1,534.5	121.5	8.1	27	2,376.0	180.0	4.0
0504	BANKING AND FINANCE	SPRING	4,158.0	261.0	17.4	51	6,534.0	441.0	9.8
0506	MANAGEMENT	SUMMER	2,772.0	252.0	16.8	55	2,772.0	252.0	16.8
0506	MANAGEMENT	FALL	13,068.0	1,188.0	79.2	229	15,840.0	1,440.0	32.0
0506	MANAGEMENT	WINTER	6,336.0	576.0	38.4	119	22,176.0	2,016.0	44.8
0506	MANAGEMENT	SPRING	6,633.0	603.0	40.2	126	28,809.0	2,619.0	58.2
0509	MARKETING AND PURCHASING	SUMMER	148.5	13.5	0.9	2	148.5	13.5	0.9
0509	MARKETING AND PURCHASING	FALL	1,584.0	144.0	9.6	30	1,732.5	157.5	3.5
0509	MARKETING AND PURCHASING	WINTER	2,871.0	261.0	17.4	58	4,603.5	418.5	9.3
0509	MARKETING AND PURCHASING	SPRING	4,009.5	364.5	24.3	81	8,613.0	783.0	17.4
0514	SECRETARIAL STUDIES	SUMMER	11,440.0	771.0	51.4	124	11,440.0	771.0	51.4
0514	SECRETARIAL STUDIES	FALL	36,465.0	2,569.0	171.3	474	47,905.0	3,340.0	74.2
0514	SECRETARIAL STUDIES	WINTER	31,669.0	2,194.0	146.3	339	79,574.0	5,534.0	123.0
0514	SECRETARIAL STUDIES	SPRING	21,065.0	1,425.0	95.0	230	100,639.0	6,959.0	154.6
0606	COMMERCIAL GRAPHICS	SUMMER	5,148.0	293.0	19.5	47	5,148.0	293.0	19.5
0606	COMMERCIAL GRAPHICS	FALL	22,737.0	1,543.0	102.9	136	27,885.0	1,836.0	40.8
0606	COMMERCIAL GRAPHICS	WINTER	17,754.0	1,099.0	73.2	111	45,639.0	2,935.0	65.2
0606	COMMERCIAL GRAPHICS	SPRING	15,081.0	969.0	64.6	88	60,720.0	3,903.0	86.7
0703	DATA PROCESSING	SUMMER	4,268.0	346.0	23.1	83	4,268.0	346.0	23.1
0703	DATA PROCESSING	FALL	10,824.0	802.0	53.5	179	15,092.0	1,148.0	25.5
0703	DATA PROCESSING	WINTER	6,132.5	497.0	33.1	72	21,224.5	1,645.0	36.6
0703	DATA PROCESSING	SPRING	12,721.5	877.5	58.8	144	33,946.0	2,522.5	56.1
0801	EDUCATION, GENERAL	SUMMER	0.0	0.0	0.0	0	0.0	0.0	0.0
0801	EDUCATION, GENERAL	FALL	495.0	45.0	3.0	15	495.0	45.0	1.0
0801	EDUCATION, GENERAL	WINTER	693.0	63.0	4.2	14	1,188.0	108.0	2.4

TECHNICAL EDUCATION PROGRAM

# ASSOCIATE DEGREE OBJECTIVE	QUARTERLY				YEAR TO DATE			PROJECTED	
95303 ENGINEERING GRAPHICS TECHNOLOG	CONTACT HOURS	CREDIT HOURS	15/CR F.T.E.	NO. OF STUDENTS	CONTACT HOURS	CREDIT HOURS	45/CR F.T.E.	F.T.E.	CURR % OF
04 GREENVILLE TECHNICAL COLLEGE	22,561.0	1,218.0	81.2	124	80,162.5	4,518.5	100.4	98.0	102.4%
07 ORANGEBURG-CALHOUN TEC	10,208.0	621.0	41.4	52	40,117.0	2,403.0	53.4	82.0	65.1%
08 PIEDMONT TECHNICAL COLLEGE	13,304.5	817.0	54.5	52	43,725.0	2,724.5	60.5	69.6	86.9%
09 SPARTANBURG TECHNICAL COLLEGE	0.0	0.0	0.0	0	1,540.0	100.5	2.2	7.0	31.4%
11 TRI-COUNTY TECHNICAL COLLEGE	10,829.5	628.5	41.9	67	42,817.5	2,520.0	56.0	67.0	83.5%
12 YORK COUNTY TEC	5,137.0	338.0	22.5	20	17,160.0	1,086.5	24.1	25.0	96.4%
ENGINEERING GRAPHICS TECHNO SYSTEM TOT.	84,690.1	5,140.0	342.6	420	309,442.1	18,968.5	421.4	447.6	94.1%
95304 ARCHITECTURAL ENGINEERING TECH									
04 GREENVILLE TECHNICAL COLLEGE	22,000.0	1,165.0	77.7	111	89,039.5	4,729.5	105.1	91.0	115.4%
06 MIDLANDS TECH COLLEGE - BELTLINE	13,073.5	850.5	56.7	65	51,458.0	3,475.5	77.2	112.0	68.9%
01 TRIDENT TECH. COLLEGE-NORTH CAMPUS	7,254.5	426.5	28.4	35	31,823.0	1,882.5	41.8	26.0	160.7%
27 TRIDENT TECH COLLEGE-PALMER CAMPUS	0.0	0.0	0.0	0	209.0	11.0	0.2	0.0	0.0%
ARCHITECTURAL ENGINEERING T SYSTEM TOT.	42,328.0	2,442.0	162.8	211	172,529.5	10,098.5	224.3	229.0	97.9%
95305 CHEMICAL ENGINEERING TECHNOLOG									
01 TRIDENT TECH. COLLEGE-NORTH CAMPUS	8,618.5	530.5	35.4	27	31,102.5	1,994.0	44.3	27.0	164.0%
27 TRIDENT TECH COLLEGE-PALMER CAMPUS	148.5	13.5	0.9	1	148.5	13.5	0.3	0.0	0.0%
CHEMICAL ENGINEERING TECHNO SYSTEM TOT.	8,767.0	544.0	36.3	28	31,251.0	2,007.5	44.6	27.0	165.2%

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RUN DATE: 05/13/75
75-3

STATE BOARD FOR TECHNICAL AND COMPREHENSIVE EDUCATION
DIVISION OF PLANNING AND RESEARCH
INSTITUTIONAL UTILIZATION REPORT

PAGE 12
100012

07 - ORANGEBURG-CALHOUN TEC

CLASSROOMS:

		-----ROOM UTILIZATION RATE-----			-----STATION OCCUPANCY RATE-----			---------SPACE FACTOR---------		
		DAY	EVENING	TOTAL	DAY	EVENING	TOTAL	DAY	EVENING	TOTAL
BLDG	ROOM	0800-1500	1800-2200	0800-2200	0800-1500	1800-2200	0800-2200	0800-1500	1800-2200	0800-2200
100	00120	0.000	0.000	0.000	0.000	0.000	0.000	0.0000	0.0000	0.0000
200	00201	25.714	31.250	23.809	67.778	44.333	74.000	1.9590	2.7657	1.0492
200	00201A	50.000	50.000	46.825	120.571	118.356	124.305	0.3241	0.9265	0.2347
200	00205	71.428	43.750	50.793	97.457	92.736	84.607	0.5500	2.0576	0.4340
300	00305	75.714	68.750	59.523	75.940	73.939	78.289	0.4743	1.1721	0.3377
300	00306	75.714	87.500	64.285	72.327	92.857	76.424	0.4974	0.7333	0.2964
300	00307	72.857	59.375	59.523	94.353	76.053	97.279	0.4952	1.3059	0.3257
300	00320	47.142	100.000	51.587	104.545	119.583	111.949	0.5527	0.4983	0.2620
400	00403	91.428	87.500	77.777	74.115	65.714	71.361	0.4320	1.0362	0.2726
400	00404	48.571	87.500	53.174	62.745	78.333	76.607	0.8938	0.6925	0.3620
400	00405	70.000	93.750	67.460	95.238	75.333	86.961	0.4086	0.8437	0.2493
400	00406	65.571	84.375	59.523	107.500	76.049	94.178	0.3695	0.9286	0.2643
500	00506	37.142	40.625	30.952	135.385	70.769	113.846	0.5636	2.1565	0.4468
500	00507	60.000	68.750	50.793	50.619	76.909	68.562	0.5067	1.1639	0.4814
700	00701	37.142	37.500	32.539	141.026	80.889	122.602	0.4982	1.7125	0.3634
700	00704	38.571	43.750	36.507	124.173	83.333	112.899	0.5225	1.5257	0.3427
800	00801A	67.142	62.500	57.936	71.454	108.333	82.078	0.5943	0.9212	0.3333
800	00806	40.000	0.000	22.222	100.000	0.000	100.000	0.6167	0.0000	0.6167

LABORATORIES:

		DAY	EVENING	TOTAL	DAY	EVENING	TOTAL	DAY	EVENING	TOTAL
100	00119	0.000	0.000	0.000	0.000	0.000	0.000	0.0000	0.0000	0.0000
200	00202	95.714	68.750	65.079	56.667	63.409	56.476	0.7901	1.9014	0.5532
200	00203	74.285	25.000	50.793	103.846	85.000	97.812	0.5296	4.2059	0.4569
200	00206	57.142	37.500	41.269	135.000	77.500	121.731	0.5296	3.0753	0.4518
300	00302	71.428	0.000	27.692	60.000	0.000	60.000	1.1630	0.0000	1.1630
300	00303	60.000	21.875	48.412	54.857	48.000	53.508	2.0191	13.8452	1.4253
400	00401	60.000	43.750	50.793	74.000	120.833	94.378	1.3070	2.4015	0.7523
400	00402	65.714	59.375	57.936	86.616	86.184	81.456	1.0955	2.4609	0.4832
400	00407	17.142	62.500	28.571	47.917	120.000	77.194	7.0652	1.6927	1.2795
500	00503	74.285	0.000	44.444	71.474	0.000	71.131	0.2675	0.0000	0.2027
500	00504	57.142	0.000	44.444	56.574	0.000	51.705	1.0491	0.0000	0.2935
500	00505	20.000	0.000	12.698	114.286	0.000	112.500	1.0616	0.0000	1.4236
700	00702	47.142	87.500	53.174	109.091	25.000	74.567	3.0625	15.7500	2.1491
700	00702A	92.857	0.000	61.111	100.000	0.000	100.000	1.0872	0.0000	0.9177
700	00702B	0.000	0.000	0.000	0.000	0.000	0.000	0.0000	0.0000	0.0000
700	00703	40.000	87.500	51.587	92.296	40.000	75.000	4.7482	11.7857	2.7077
700	00705	55.714	96.875	64.285	167.150	321.147	224.629	1.2608	0.9738	0.5323
700	00706	92.857	0.000	61.111	93.333	0.000	92.333	1.4000	0.0000	1.1818
800	00801	62.857	50.000	49.206	62.712	79.583	84.009	1.5713	4.0378	1.1112
800	00802	0.000	0.000	0.000	0.000	0.000	0.000	0.0000	0.0000	0.0000

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THE HUMANITY IN MANAGEMENT INFORMATION SYSTEMS

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More emphasis should be placed on "human factors" in the information management systems. They should be tailored to their users--the administrators, faculty, and students. Easy communications with an information system is a basic necessity, just as is the ability to get simpler answers to the most complex questions. All levels of the university community should be served by the system, and each level should be able to communicate in a way that is unique to its need. The complete management information system must be prepared to change; to shrink as well as grow to meet the needs of the changing university environment.

1. The University Administrator

Within the past ten years we have seen dramatic changes in the university environment. Enrollments at first climbed to new highs, then declined to new lows at some of our institutions. Many, if not most colleges and universities accepted the computer as the door at the end of the hallway to the future of information handling. The result of all this has been to increase the complexity of the university infrastructure.

University administrators have always had a problem with information. In the past, when they needed to know the number of full-time enrollees, they often triggered monumental efforts, the results of which usually produced crude approximations. Good, correct information was hard to come by. Some questions were never asked because the answers were out of sight. For example, what will be the cost to the university in faculty salaries for the next semester in the history department? It was impractical for this question to be answered because the information necessary to answer it was just not readily available. The number of faculty members necessary to teach the history courses was not known because the number of courses to be offered was not known. The number of courses to be offered was not known because the number of registering students was not known either. The administrators could only make semi-educated guesses, and they were often wrong.

And the administrators had other problems as well. Only in the halls of congress do we find more special interest groups than in the halls of our higher education institutions -- students, faculty, administration, financial aid officers, registrar, counseling services, student services, governmental agency representatives, etc. Each interest group submitted its needs to the administrators and expected a timely, if not favorable, response to its requests. Unfortunately, in many cases, the real world had taught these groups to ask for more than they needed. Thus resource planning and allocation was a very difficult task for the administrators.

Today, administrators have the computer. Yet, in general, administrators are not data processing technicians. They must deal with people, not machines. When they ask questions, they must ask qualified personnel to input data and interpret results for them. When they plan and make decisions, they need planning and modeling tools that they can understand, although they can never touch or see them. The administrators are almost totally dependent on the data processing staff for their information today.

2. The University Population

Ironically, the introduction of the computer into the university environment has had the effect of creating a new special interest group within the university population -- the data processing staff. This group has become the defacto manager of information in the university. It interfaces with the entire university environment. Almost all college students have identifying computer numbers and use the computer to select courses, pay fees and register. Most departments are notified by computer printout of program changes made by students on their rosters. Department heads use the computer to schedule courses and final examinations efficiently and without conflicts. Faculty members are better able to plan their schedules because their classroom assignments are known well in advance. Counseling services track student progress, sometimes through to job placement, by using the computer. The computer may even decide that a degree or award should not be conferred because of datum that it has. The payroll departments computerize their information in order to satisfy the need for timeliness and accountability. Planning offices track budgets closely with the aid of online computer-based data banks. Individuals engaged in research find machine time available for their use. In essence, every person in the university environment interfaces directly or indirectly with the machine-generated information processes and the data processing staff.

3. The University Management Information System

As we have already seen, the data processing staff is the group within the university that controls the information and interfaces with the entire university environment. It is, therefore, vitally important that all of the other groups in this environment understand the management information system and have the ability to transmit and receive information to and from this data processing group. It has been postulated that the MIS is a management tool; that it is for management use only. My experience would indicate that this is not true. The total management information system is a child of the interaction of the entire environment:

Financial aid and admission offices input student information.

Financial departments input budget data.

Students input requests, such as course selection criteria at registration time.

Faculty inputs teaching and research requirements, such as the number of courses they wish to teach, and so forth.

In a total MIS environment, each and every group that might be affected by the operations of the MIS should participate in its planning and design. Yet, even those managers who believe that the MIS is their exclusive tool often are not involved in its planning or design. Indeed, if any university group is left out of these considerations, it will not understand the MIS, its purpose or its functions. Not understanding the system leads to faulty input and misinterpreted output. For example, if administrators are not aware of the fact that students are on file in the data base in both alphabetic and zip code order, the administrators might ask for an alphabetic listing in order to find those students who live in a particular zip code area. Too often the data processing technicians responsible for screening such administrative requests for validity will let this type of request pass because they assume that the administrators know what they are doing. Unfortunately, the administrators do not know what to ask for if they do not take part in the design of the system. The same is true of any of the other university groups. I recall when, as a college student during course registration, I queued up on line with my fellow students in order to register for a course. When I came to the front of the line I learned that the course I had wanted had been closed all along. My fellow students and I should have demanded a system whereby timely information would have been made available to the registrars and students during the registration period. The lack of timely information was a factor in the burdensome course changes that followed the course registration period because student course schedules had to be rearranged around the closed courses. The first step towards a total MIS in this case would have been the establishment of a preregistration and modeling system.

It is equally important for the users/designers of the MIS to know what kind of information is not stored in the computer. It should be obvious to the administrators that, in general, they should not expect a non-trivial answer to the following question: How many college juniors currently in other institutions will transfer to register for a history elective and require financial aid in this institution? Administrators will not ask that question because they understand that the MIS they are using could not possibly contain that information.

Lastly, it is important that some degree of security be designed into the MIS by all parties involved in order to ensure that no group may violate the privacy of any other group. I will not elaborate on this issue, it being both an obvious need and an inescapable goal.

4. A Sample Management Information System

The University Application Processing Center of the Research Foundation of the City University of New York was founded in the early nineteen sixties to pave the way for a centralized admission system for the City University campuses. At the time of its inception, students filed separate applications for admission with each campus of the university. The U.A.P.C. was given the task of computerizing the application acceptance process and feeding the applicant's information to the accepting campus. The U.A.P.C. began to use a small computer and developed several batch oriented systems to do this work through the nineteen sixties. By 1966, the U.A.P.C. was sending complete applicant information to more than half of the university campuses. The initial system was a success in that the colleges involved no longer had to invest time and money to handle all of these pieces of paper. In the next five years, we began to expand the operation to pick up the student's information before they had graduated from high school. More application programs were written, and by 1972, a small MIS evolved. By 1973, the U.A.P.C. had an MIS that met most of our data base inquiry needs. At this time, we were processing almost one hundred thousand applications each year. The criteria we had used to design and build the MIS were, in order of importance:

Reliability
Function
Natural language
Performance
Loose data base integration and simple data structures.

The most important aspect of the MIS was that it be reliable. We wanted to know that whenever we wished to retrieve information, the system would be up and running and would accept our questions.

Next, we felt that the system should function the way it was designed and documented to function. That may sound simple, but it can be very difficult when you consider that an answer that contains unasked for information is an improper answer.

Next, we felt that it was necessary that the human beings using the MIS be able to ask their questions in a language that approximated English as closely as possible. That way it was not necessary to train the user community in a new "foreign" language for communications with the system. In particular, wherever possible, the MIS would answer a query by echoing the original question in English, or respond with tabulated results. For example, if the query was "How many students applied to Brooklyn College and live in zip code 11234 and need financial aid?", the answer would come back as "The number of students that applied to Brooklyn College and live in zip code 11234 and need financial aid is 35". And far as performance was concerned, we wanted to receive answers to most questions within one hour.

We also felt that it would be unwise to tie our data together in such a way so as to make it impossible for us to use the MIS if any MIS data was unavailable. For example, if all information was stored on one magnetic disk and the disk developed a hardware problem, we would not have been able to use the MIS. We therefore kept the data base loosely coupled, with each semester's student applications and work on a separate file. We also made sure to keep the files in simple sequences with as few interrelated links as possible. This organization insured that the MIS could still function with some of the data, even though the rest of the data was not available. These decisions later proved wise because they enabled us to add and modify both the online data base and the MIS applications while the MIS was being used.

Thus, with all of these factors in mind, our management information system was developed. For some, the term Management Information System brings to mind a colossal machine, with lights blinking, tape moving, and a poor hapless human being chained to a television-tube-like apparatus. But the MIS at the U.A.P.C. made as much use of the human resources as it did the computing resources. Data collection began with the work done by a person on the staff. In a methodical fashion, the staff member Minnie left our offices almost every day with a camera to photograph the high school files of graduating seniors. Most administrators would have sent turn-around documents to the schools, in expectation of their being returned with the required academic information. Yet, we found that it was impossible for the turn-around document method to work in the New York City environment for a variety of reasons:

The personnel at the high schools were too busy to respond in time.

The data they entered on the turn-around document forms was often incorrect and almost impossible to verify without examining the source document.

Some high school personnel were unfamiliar with the forms and found it difficult to fill them out properly.

It was to difficult to train a group of several hundred people to fill out the forms properly when the personnel turnover was significant, and their school-assigned tasks were ever-changing.

The student grading scheme differed from one high school to another.

Instead, with enlarged photographs of the high school records, we were able to encode and enter the entire record of a graduating senior in less that one minute. This speed was possible because of a specially trained data entry staff at the U.A.P.C. A mini-computer was used to verify the entered data for syntactic validity. The data was then input to a large computer. Each student's information was compiled into a single record and stored on the data base. At this point an official high school transcript was produced, copies of which were sent to the students and their school personnel for verification.

Errors were corrected by allowing the high school personnel to return the transcripts with changes clearly marked on the form. These changes were input to the mini-computer, and new transcripts eventually produced for reexamination.

At this point the data base consisted of the correct high school records of the graduating seniors. The next step was to add the college choices of these seniors to their records. The City University of New York followed an open enrollment policy. Any graduating high school senior could specify, in order of preference, up to six colleges and programs of the City University as his or her choices. Applications for admission were received by our office from the students themselves, and matched against the records on our data base. The choices were input to the mini-computer, and filled into the appropriate records.

Because we had captured student information from the first year of high school through to the application to college, we were able to offer several novel features. The final transcript that was produced for the student had not only a record of the student's high school career, but a college application as well on a single form. The students had this form with them when they saw their high school counselors, college counselors and the staff at the City University's Office of Admission Services (O.A.S.). The O.A.S. was primarily a college admissions counseling service for graduating seniors whose purpose it was to help the students choose wisely from among the hundreds of programs available at City University. The O.A.S. staff was supplied with computer terminals, and had ready access to both the student's transcript/application as well as our data bases. It was possible for individual counselors to determine how many other students had already applied (and been accepted) to a specific program at a specific college in the university. This made the job of evaluating a specific student's chances for acceptance to that program based on their high school performance easier.

We also made a terminal available to the Vice Chancellor of the City University system. With a terminal, he could ask for any information available about the admissions process on a minute by minute basis. As mentioned earlier, it was possible to update the data bases even while the system was running. The users could therefore query the current admissions status at any point in time. Thus it was possible for the Vice Chancellor to ask, "How many students would be accepted to program X at campus Y if they have a high school graduating average of at least 84 and require financial aid?" The answer to this question was correct to the moment that the question was asked because the data on the file was kept current. Since income information was also available, the Vice Chancellor could forecast the financial needs of the new college student population as a group. Some private student information was kept on file, but not available to any online users on a individual student basis.

It was possible to simulate the allocation of all of the students on the data bases to the colleges they had requested and examine the results of the simulation without actually affecting the acceptance status of any of the students. This was necessary because the number of seats available for entering freshman at each of the campuses was limited, and only a simulation run could determine if these seats would be completely filled given the acceptance criteria.

Another user group was the student population. Very often, telephone calls would come in from worried students asking us to verify that their applications had indeed been processed and that they were being considered for admission. The queries were answered by the U.A.P.C. staff person answering the telephone calls. A more sophisticated method for answering the students' questions would have been to have installed telephone lines directly into the computer that would have enabled the applicants to query the data bases for themselves. They would have called and heard a recorded message asking them for identifying information which would have permitted them to access their own records. They would then have been told the status of their applications.

5. The Total Management Information System

The implementation of a responsive MIS is an evolutionary rather than a revolutionary process. Successful management information systems are not born overnight, nor in general all at once. They usually evolve from one or more specialized programs or applications. Sometimes this evolution can take several years or even a decade. In each case, the community is careful to plan for the evolution so as not to adversely impact any group. The plan also calls for as little impact as possible on day to day operations.

For example, one of th most popular management information systems evolved from a series of application programs at a large aerospace company. This evolution took place over five years. It began with an attempt to manage the files of very few of the company's groups, and those whose data files contained information whose structure was very simple. The MIS was gradually changed to encompass the entire community, managing files whose information was very complicated and interdependent. Among this company's data bases is one that describes over two million parts, and is queried many thousands of times each day.

Another firm, one of the larger insurance companies, uses an MIS today that also evolved from several application programs servicing the diverse groups of that company. In this case, the original programs managed files whose structure was complicated. But these programs took several years to develop. The evolution into the MIS at the insurance company involved the integration of these separate application programs into one large system. Today, the data bases contain information on the entire company's business. The Individual Policy Holders data base alone contains over three and one half million records, totaling over seven billion characters, and is queried over five and one half thousand times each day. All of this would not have been possible without careful planning of the MIS evolution.

It is interesting to note the effects of the MIS evolution on the people in the data processing groups within these two companies. In both cases, managers found that the cost of running the system shifted from people to machines. Staff sizes were reduced. Yet individual salaries jumped. This was due to the changing job requirements of the data processing personnel. Whereas, before the MIS, the typical employee was a data entry clerk, the typical employee became a systems analyst or a specialist. In addition, as the job requirements changed, the turnover rate among employees rose. This turnover resulted in a rising cost for employee education and training. There is no reason to believe that the same effects will not result in the university environment.

Another cost-related observation that may be taken into consideration by university and data processing administrators is that a management information system has relatively high fixed costs and low variable costs. That is, it is expensive to develop it and to start it, yet relatively inexpensive to maintain and operate it. The MIS may be up and running all day and queried often by many users, yet the operating costs are low compared with the fixed costs. This fact may lead to the decision on the part of university administrators to make more and more data online and available to more personnel in the university environment as soon as possible. It is the logical thing to do since the initial startup costs will already have been borne.

6. Conclusion

An MIS does not control anything. An MIS is an information gathering and dissemination tool which permits people to attempt to control situations of which they may be aware. This means that the designers and planners of an MIS do not relinquish control of their data to the computer. It is their responsibility to design the MIS functions in such a way so as to permit the human being to control the data. An MIS is a creature whose evolution requires careful consideration and planning. Once the MIS is in operation, it must be auditable. It must be subject to periodic review in order to evaluate the responsiveness of its functions to the community it serves. This evaluation may uncover problems in the human-machine interface between the MIS and its community. If the MIS is found to be improperly designed, then it should be redesigned or scrapped, because the only purpose of an MIS is to serve the community.

Whenever the MIS planners find an unplanned for or inadvertent function in the new system, they should examine it for its usefulness, discarding it if it is found to be unnecessary. For example, if a list of persons shows the addresses of those persons along with their names, and the names are all that is required, then there is a problem. Either the addresses should indeed appear, and the system documentation should be modified to reflect this new fact, or the addresses should not appear and should be deleted from the listing as unnecessary. It is very common for users of any computer system to depend on unplanned "goodies", only to find that these "goodies" will not be around in the future. Before new functions are incorporated into the MIS, steps should be taken to ensure that the changes do not adversely impact anyone. This also means that every attempt should be made not to degrade the performance of the MIS when modifying it. The people who plan, design, and control the MIS have a responsibility to the people that are served by the MIS. It is to make the MIS as responsive, accessible and humane as possible.

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COMPUTER ASSISTED HIGHER EDUCATION MANAGEMENT: IMPOSSIBLE DREAM OR PRESENT REALITY?

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This paper presents the results of a nation-wide survey of models and their impact on institutional planning and decision making. The increasing use of analytical tools to analyze the future consequences of management action are also reviewed.

COMPUTER ASSISTED HIGHER EDUCATION MANAGEMENT: IMPOSSIBLE DREAM OR PRESENT REALITY?

Since the advent of computers, there has been endless discussion of whether computers will be used in areas other than to perform simple routine tasks and replace humans where judgmental decisions are involved.

Norbert Weiner, the father of cybernetics, was an early proponent of the position that computers would be involved in all areas of human activity, whereas Mortimer Taube was an early champion of the restricted view of computer use. More recently, this argument surfaced between Drs. Frank Ryan, the Director of Information Systems for the U. S. House of Representatives, and Carl Hammer, the Director of Computer Sciences for Sperry Univac. Dr. Ryan argued that "computer systems should either substitute for or compliment a routine procedure"[1], while Dr. Hammer suggested that "now we must learn to let machines do our mental drudgery for us; we must become a knowledge society."[2]

The purpose of referencing this decade's old argument is that it bears a direct relationship to the use of computers in higher education management, and whether or not we can ever hope to utilize computers to do anything but process transactions and produce reports for the operational level of an organization.

As might be expected, there has been considerable disagreement in literature as regards the applicability of the techniques of scientific management[3] in higher education in general and the use of analytical models in particular. As Cheit noted, "the application of the systems approach to management, even to higher education management, is not new. Opinion is divided on the usefulness, limitations, consequences and dangers of this approach."[4]

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[1] "Ryan, Hammer Theories Collide on DP's Pathways to the Future." COMPUTERWORLD, November 22, 1976, page 4.

[2] Ibid.

[3] The attempts to improve management systems and adopt the concepts of

There are several issues around which the disagreement centers. They are not new, and they have long been at the center of the ancient debate between administrators, and faculties about the "proper" role of administrators in higher education. Some of these are as follows:

1. Defining and measuring educational outputs are difficult tasks.
2. The production functions of higher education are not concisely defined, and there is no accepted formula for determining the resources required to produce a unit of output.
3. Quantifying basically subjective concepts such as value added by the institution is a problematical task.
4. The old issue of centralization versus decentralization and,
5. as Rourke and Brooks noted, the inherent conflict between administrative efficiency on the one hand, and academic effectiveness on the other.[5]

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scientific management are deeply rooted in the concept of system analysis which ' . . . focuses attention upon the objectives of an enterprise and then concentrates upon the input factors and the dynamic process involved in the realization of those factors.' The systems approach to organizational analysis means simply trying to access the whole organization rather than identifying one of the parts where a difficulty may be most apparent. It means looking at interior interactions to understand why the organization is operating as it is, or to predict its behavior. It means studying interaction of the system or organization with the socio-political competitive environment within which it is located and with which it is inextricably linked.

John D. Millett, Decision Making and Administration in Higher Education (Kent, Ohio: Kent State University Press, 1968), page 76.

One of the major attempts to extend the use of computers in higher education to the planning and policy making level has been the introduction of analytical modeling systems specifically tailored for institutions of higher education. However, as this author recently pointed out, "the usefulness of analytical modeling systems in higher education administration is by no means an accepted fact at the institutional level, and users of such systems have reported mixed reactions to their successes in journals and at conferences."[6]

A number of studies were conducted in the early '70's by Casasco, Evans, Gonyea, and Wartgow in an attempt to evaluate the use of planning systems and models in higher education. These efforts all dealt with a limited number of institutions and did not address the nationwide use of models.

During 1975, the Center for Educational Management Studies (CEMS) conducted a nation-wide survey of all institutions identified by developers of the following models: CAMPUS, PLANTRAN, RRPM and SEARCH. A survey instrument was addressed to the project leaders at 400 institutions in the United States, Canada, South America and Europe. This survey was followed by a separate survey of academic and financial administrators who were asked to comment on their perceptions of the relative measure of success enjoyed with the modeling system. The results of this research

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[4] Earl F. Cheit, "The Management Systems Challenge: How to be Academic Though Systematic" (Washington: Paper presented to the 56th Annual Meeting of the American Council on Education, Oct. 11, 1973), page 1.

[5] Francis E. Rourke and Glen E. Brooks, The Managerial Revolution in Higher Education (Baltimore: The John Hopkins Press, 1966), page 3.

[6] Paul J. Plourde, "Institutional Use of Models: Hope or Continued Frustration?" New Directions for Institutional Research 9, (Spring, 1976), page 17.

effort were published in a monograph[7] in 1976 and the summary of the findings of that research effort are listed in Attachment A.

The initial research effort also uncovered opportunities for future research endeavors and CEMS, with this author as the principal investigator, has conducted two follow-ups on the original study. The first resulted in a survey instrument sent to 270 respondents to the first questionnaire. This questionnaire solicited user's perceptions of the following questions:

1) what are the reasons that models will likely be used in their institution in the future,
2) what are the reasons that the development and use of models should be fostered, and
3) what was their perception of the preconditions for future use of models.

The results of this survey instrument will be reported in a forthcoming CEMS monograph to be available in the Spring of 1977.

The other follow-up dealt with the institutions that were in the process of implementation in 1975. The purpose of this research was to determine whether there was a significant difference between those institutions that implemented in that year vs. earlier years. The results of this effort will also be included in the aforementioned monograph.

Comparing the results of the nation-wide study on the use of models, with the efforts of Casasco, Evans and Wartgow listed in Attachments B, C, and D respectively, we find that their findings were not substantively different than the results of this research effort.

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[7] Paul J. Plourde, Experience with Analytical Models in Higher Education Management, (Amherst, Massachusetts: CEMS, June, 1976).

As was noted in the monograph,

> "both the interest in and utilization of analytical models increased substantially since the research efforts of Evans, Gonyea (1971), and Wartgow (1972). The necessity for the institution to commit itself to assign personnel to implement the models and to utilize the model once implemented, continues to be of the utmost concern. The findings here show that there is considerably more willingness to rely on models for long-range planning than for day-to-day decision-making. Gonyea's observation in her study of institutions known to have access to planning or simulation models remains true; she identified the major problem as getting decision-makers to use the outputs and support the implementation of the planning system. The mere number of institutions implementing such systems, while indicative of a trend, does not tell the whole story, since information about the support of the organization planning to use the model is also required. Casasco's findings are also very applicable today. He stated in his conclusion that, if these techniques are to be successfully integrated into the institutional planning process, the establishment of the socio-technological preconditions for the understanding acceptance and effective implementation of these tools is essential. The dynamics of institutional behavior and the sociological aspects of college and university management is a broad, pervasive, and engaging issue that certainly extends beyond the scope of this study into the realm of the behavioral sciences. However, the crucial role that this aspect of institutional management plays in the successful implementation of the techniques discussed here merits the careful consideration of both institutional researchers who are developing new analytical and forecasting techniques, as well as the institutional managers who would in the final analysis have to utilize them.

As a concluding note, what advice might be offered from all this information for model builders and users:

1) Importance of process. It must be recognized that a significant number of professionals in the field believe that the process of using a model is as important as the model itself. The discipline required for data-gathering in a uniform fashion for input to the model and the attendant discussion on use of data output may well be the most viable aspects of model use.
2) Model simplification. Model-builders need to be aware of the model-users' desire for simplified input and output requirements.
3) Data bases. Users must develop operational data bases to support the use of models in the long-range planning process and in day-to-day decision-making processes.
4) User education. All administrators should participate in training sessions keyed to user education. It is one thing to train individuals to keep the model running, but it is quite another to develop constructive attitudes toward the usefulness of models. As one president noted, we must continue to educate our staff and batter at the stone walls of resistance and obstruction. Another respondent called for

training sessions for all administrative levels, keyed to their potential use or need of the model.

5) Organizational commitment. Unless there is an organizational commitment from a high level to integrate the use of the model into the planning or decision-making processes, the model itself will remain a play-thing for the institutional researchers, computer center personnel, and other project leaders, and few significant benefits will be derived from its use. After all, what does it accomplish to have a perfect computer implementation of a modeling system if in the end it is not understood, not supported, or not used?

The main assumption--that there are few individual successes--seems to be supported. However, the spirit of the individuals responding to both questionnaires does not seem to have been dampened by their experience. While perceptions of success were less than positive, respondents did transmit positive indications that models can contribute to managing institutions of higher education, that they are valuable for the types of decisions that they must make in their positions, and that there is a good possibility that the models will be used in their institutions in the future."[8]

In the immediate future, models are likely to continue to be used as planning tools and this is not surprising since this was their initial intention. Clearly, as was indicated in the most recent survey, there is a need for more objective data for decision-making but the usefulness of models for that purpose will necessarily have to await the integration of modeling into the data gathering and decision-making cycles.

Far too often, modeling has been seen as a peripheral activity to either data gathering or decision-making and before it is truly useful on a day-to-day basis, the modeling system will have to become an interactive component of the management information system as well as the data base. The implication is that the modeling system cannot be a separate and distinct entity from the operating system, the data base management system or the application programs. What is required is for the modeling system to be considered a part of these preceding systems and thus be resident in the computer for monitoring purposes. Similarly, the assumptions upon which the management of an institution are based need to be resident in the data base in order that data which is fed into the data base on a day-to-day basis may be compared to the management assumptions, processed through the model, and exceptions can be highlighted for management's review. In this way, modeling will be removed from the hands of the institutional researchers and computer center technicians and be made a part of the day-to-day management of the institution.

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[8] Ibid., pages 67-69.

In summary, it is clear that the use of computers for coordination and control, and strategic planning has merely touched the surface of the possible spectrum of activities. Much education, improvement of data bases, and organizational commitment to utilize computers in the decision-making process will be required before we can truly use the term "management system" with a certain degree of assurance that it exists.

ATTACHMENT A

SUMMARY OF CONCLUSIONS OF CEMS RESEARCH STUDY ON MODEL USAGE

1. Institutions that are perceived by their members as disposed to acceptance of innovation and new ideas register a greater success with the use of models than those institutions whose members do not perceive them as disposed towards innovation.
2. The most important perceived institutional need for the use of a model is the requirement for a forecasting ability.
3. The commitment of the organization at a sufficiently high level is the most important variable affecting successful use of the model.
4. While cost is a factor in the selection of a model, the data did not indicate that this is the most important factor.
5. Project leaders do not consider the use of the model more successful than administrators. In fact, it seems that where a significant variance does exist the administrators view models as more useful.
6. Models are more frequently used at the highest level of the organization (Presidents and Vice-Presidents) than at the intermediate middle-management level.
7. Models are not integrated with institutional data collection.
8. Few institutions base administrative decisions on the results of modeling and thus have not found successful use of models in day-to-day decision-making.
9. Models are used most frequently as a long-range planning tool.
10. The success or failure of the model does not vary based on the particular model used.
11. Some variance does exist in the relative measure of success experienced by institution type.

ATTACHMENT A

12. Few institutions feel that they have satisfied a considerable number of their objectives by using a model.

13. Few institutions indicate that the use of the model has been an overwhelming success or even classified their experience as highly successful. The majority of respondents indicated that the use of the model was only somewhat successful.

14. While perceptions of success were less than positive, respondents did transmit positive indications that models can contribute to managing an institution of higher education, that they are valuable for the types of decisions that they must make in their positions, and that there is a good possibility that models will be used in their institutions in the future.

15. Finally, the data indicate that more sophisticated models are not required in order for them to be useful in the higher education arena. In fact, the data seemed to indicate just the opposite need, namely, to simplify the available models and reduce the volume of computer output that the various systems produce.

Source: Paul J. Plourde, "A Study of the Usefulness of Analytical Models in Higher Education Administration" (unpublished doctoral dissertation, University of Massachusetts, Amherst, 1975), pages vii-viii.

CASASCO 1970

1. PROBLEM IS NOT THE LACK OF SOPHISTICATION.
2. TECHNIQUES ARE ONLY PARTIAL SOLUTION DEVELOPED FOR SPECIFIC PROBLEMS ISOLATED FROM TOTAL INSTITUTIONAL PLANNING.
3. MOST ADMINISTRATORS DO NOT VIEW INSTITUTIONAL DEVELOPMENT WITHIN A TOTAL SYSTEM PLAN.
4. FEW UNIVERSITIES EMPLOY RIGOROUS PLANNING METHODOLOGY.
5. ADMINISTRATORS NOT AS SOPHISTICATED AS THE DEVELOPER OR MODEL.
6. SOME TECHNIQUES HIGHLY THEORETICAL AND HARD TO GRASP.
7. ESTABLISH SOCIO-TECHNOLOGICAL PRECONDITIONS FOR UNDERSTANDING.
8. EDUCATION.

Source: Casasco, pages 75-77.

ATTACHMENT B

EVANS 1972

1. EARLY COMMITMENT AND INVOLVEMENT BY A WIDE VARIETY OF PEOPLE.
2. CLOSE ATTENTION TO TRAINING.
3. OPENNESS TO SUGGESTIONS OF THOSE INVOLVED.
4. WILLINGNESS TO TREAT THE MODEL AS MORE THAN JUST A COMPUTER PREDICTION DEVICE.
5. PLANNING ORIENTED INSTITUTIONS HAD MORE SUCCESS.
6. MOTIVATION TO IMPROVE DATA BASE WAS AN ENDURING BENEFIT OF MODEL USE.
7. INSTITUTIONS WHICH TAILORED THE MODEL AND ALLOWED FLEXIBLE USE WERE MORE SUCCESSFUL.
8. TECHNICAL IMPLEMENTATION IS MINOR.
9. THE HUMAN IMPLEMENTATION PROBLEM, THE TASK OF GETTING THE SYSTEM UTILIZED, REMAINS.

Source: Evans, pages 142-162.

ATTACHMENT C

WARTGOW 1972

1. TIME TO IMPLEMENT UNDERESTIMATED.
2. MORE SUCCESS WHEN CONSULTANTS USED.
3. LACK OF WIDE PARTICIPATION INFLUENCED FUTURE USE AND CONFIDENCE IN MODEL.
4. IN-SERVICE EDUCATION INFLUENCES UTILIZATION.
5. MODELS MOST EXTENSIVELY USED WHEN A FORMAL PLANNING PROCESS EXISTS.
6. ACCURACY OF BASE DATA INFLUENCES FUTURE UTILIZATION.
7. INSUFFICIENT TIME TO DEVOTE TO PLANNING IS A MAJOR IMPAIRMENT TO MODEL USE.
8. USE OF MODELS FOCUSES ATTENTION ON PLANNING.
9. MOST USEFUL IN INSTITUTIONS.
10. SPECIFIC NEED AND HIGH-LEVEL COMMITMENT MUST EXIST.

Source: Wartgow, pages 200-218.

ATTACHMENT D

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MANAGING THE INFORMATION RESOURCE IN A COMPLEX ENVIRONMENT

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Information pervades all aspects of the business environment, and is of vital importance to a large retailer. This paper reviews the organization of the information resource in Sears, and the administrative policies and procedures which have been established for the activity. In addition, this paper covers staff recruitment and training, systems and programming standards, and equipment operation and control.

MANAGING THE INFORMATION RESOURCE IN A COMPLEX ENVIRONMENT

I am sure you have heard the statement that the thing most necessary for success in retailing is to have the right merchandise at the right price in the right quantity at the right place. We believe this at Sears and try hard to accomplish it. But if we don't always do it, the reason can frequently be that we didn't have the right information, in the right place, at the right time. Clearly, information is a resource as essential to business as the merchandise, money, and men and women who run the company.

It probably isn't necessary to say that Sears is the world's largest retailer of general merchandise distributing goods through some 3800 selling locations. Our headquarters and most of our buying departments are located in Chicago. The company's five territorial or field offices, each headed by an Executive Vice-President, are located in Alhambra, California; Atlanta, Georgia; Dallas, Texas; St. Davids, Pennsylvania; and Skokie, Illinois. These territorial offices administer the company's selling units and field operations, while the administration of our buying departments and corporate offices takes place in headquarters. I mention this because I will be referring to headquarters and the field in my remarks, and I want you to know the meaning of the terms in Sears.

Well, this leads to my subject this morning. I would like to tell you about the information resource at Sears, the people and facilities that constitute it, and how it is managed and controlled. As you might expect, it is a rather complex activity involving a large staff of professional and technical people and a network of data centers and communication facilities stretching over this nation and much of the world.

Maybe a little history and policy is the place to start our discussion. Prior to 1962, information processing - or data processing, as we call it, was handled by a variety of activities and in a number of different ways. In 1962, Sears consolidated all information processing functions into one activity and gave that organization the responsibility for the company's data processing research program and for the evaluation, development, and application of data processing methods and equipment throughout the corporation.

With this consolidation, we adopted some general policies which have proven important:

1. We consolidated the communications function into and under the data processing responsibility in recognition of the interaction of communication and data transmission facilities with computer and data processing operations. We view our information processing requirement as a network made up of communications and data processing facilities. Obviously, communications lines and equipment must work in harmony and in common purpose with our computers and data processing operations.

2. We adopted and follow the principle of centralized system design and programming. In this connection, we develop and, from a programming standpoint, maintain all data processing systems in headquarters. There are many advantages to this policy:
   a. It provides the company with uniform systems.
   b. It enables us to use our manpower more efficiently, and to maintain and modify programs more economically.

c. It also facilitates auditing control and system security, and makes it easier to consolidate information from a corporate standpoint.

3. As a third policy and for operational and security purposes, we separated the responsibilities of systems development from that of computer or data center operation. While systems and systems changes are distributed through our headquarters central library to field data centers, the implementation and operation of these systems in the data center is a field responsibility. Of course, the headquarters staff assists the small field staff during implementation, but operation is taken over by the field.

4. We recognized the importance of economy and efficiency in our widespread computer operations, and decided very early on the use of an assembler language instead of a high level language for programming. Our choice of assembler language programming instead of the more common high level language was, and still is, a bit agonizing. But for our circumstances, we believe the choice was right. By training our own people and developing and maintaining systems centrally, we minimize the developmental process and obtain maximum benefit from the widespread and high volume operation of the systems. With nineteen rather large data centers running similar systems in support of local stores and

installations, a modest increase in computer operational efficiency will offset any extra programming effort.

5. We found it advantageous and, in fact, necessary to recruit and train our systems and programming personnel instead of hiring professionals from the outside. Regarding this policy, we recruit about seventy-five young people from the colleges and within Sears each year, and provide a three months data processing training course which is conducted by our professional staff. In addition to this basic programming training course, we provide approximately 16,000 class man-hours of advanced and videotape training each year to maintain the expertise of our staff.

6. Regarding equipment, we decided that, even though an economic case could be made for the purchase of the computer equipment, Sears would avoid commitments that extended four or more years beyond the date that new equipment was available. This decision was based on our concern for technological or functional obsolescence. We were embarking on a major development and implementation effort and, as a result, our equipment needs would be growing at a rapid pace. In addition, the computer industry was growing rapidly and had clearly demonstrated significant improvements in price/performance of computers and peripheral devices based strictly on improved technology. These trends of rapid growth of Sears needs, coupled with

constant technological advancements of computer products, continue today and still cause us to guard against long-term commitments, especially in the area of our general purpose computers.

7. From the start, we recognized the importance of the user in the systems development process, and took steps to obtain the full interest and involvement of user activities with professional systems people in a joint undertaking. This policy is probably the most important of the points I have mentioned. Systems development, communications, and data center operation are service functions in Sears and, as such, are not under the administration of the stores and company activities which they support. We function somewhat as software and service bureau-type facilities, charging company units for services performed. But we long ago recognized the vital role of the user, or client, in the systems environment and the fact that the user cannot relinquish his responsibility for systems performance and results just because the manual methods and procedures have been converted to a computer system. It is still the client's system, and he must actively participate in system design, and must approve the final product. The client must also be sure that the resultant system has adequate system controls.

Turning now from matters of policy, let me tell you how we have organized the information processing activity. The organization is broadly divided into three departments; namely -

1. The Data Processing Systems Department, composed of four large systems development groups and a technical support function. The systems groups follow company organizational lines with one group developing corporate headquarters applications, another responsible for retail store applications, another serving catalog and warehousing activities, and the other handling general systems which cut across organizational lines. The technical support group is made up of some of our most senior professionals. This group is responsible for recruiting and training our professional staff, for computer operational or systems software, and for staff activities which include computer equipment research and selection, systems and programming standards, and data base administration.

2. The Communications Department - responsible for voice communications throughout Sears, and for securing the most appropriate level of service from the communications industry and carriers. In addition, this department is responsible for telecommunications software, equipment, and network design.

3. Data Center Operations involves the operation of the company's computer centers. Data centers can be either headquarters or field. Headquarters data centers support programming staffs with test facilities and provide computer operations for corporate applications. Field data centers provide

computer facilities to service operational requirements of stores and installations within the geographic area of the field data center.

One further point about organization: as indicated before, Sears has divided functional responsibilities between headquarters and the field and, accordingly, certain aspects of the three departments mentioned exist in both areas. Research, systems development, and maintenance are accomplished in the headquarters departments. The small systems and communications staffs in the field are responsible for implementation and the operation of the systems which have been developed by headquarters. In addition, the field staffs provide technical support to the field data centers for operational or other local requirements.

Well, with these points about policy and some understanding of our organization, let's talk about administration - how we manage and control the systems and data processing function.

I believe this part of our discussion should start with planning - for without good, sound plans, the administration and control of a complex data processing program is difficult, if not impossible. At Sears we handle data processing planning this way:

A staff group - called Functional Advisors - serves as the primary planning activity. This group is part of the data processing organization, but the individuals represent the principal functional areas of the company, such as merchandising, operating, accounting, personnel, credit, and factory operations. These individuals wear two hats: on the one hand they serve as account executives for all data processing systems in the functional area which they represent. In this role they work with the client or functional department in the origination and control of systems projects and, in turn, with our professional systems organization in the development and implementation of the system. These advisors are staff in responsibility, i.e., they do not manage either side of the system development equation. But with a direct reporting relationship to me, and a dotted line relationship to the functional officer they represent, they become an effective force in the DP program.

Under the second hat, these advisors act as a central committee responsible for the preparation and maintenance of the DP plan. One advisor, presently the Merchandising Advisor, serves as chairman of this Planning Committee and gives general direction to the group effort. The Committee does not make specific planning decisions, but rather assembles and documents the plan for all data processing and communications activities. As DP plans and projects must consider functional needs and objectives as well as systems development and equipment capabilities, we have found this Advisory Group to be particularly effective in preparing and coordinating our DP plan.

With this background about our planning process, let me explain our system development procedure. A systems project or job begins with the submission of a Systems Study Request, which briefly states the problem and the benefits expected from the system or system modification. The Study Request will usually originate with a user department, be processed through the Functional Advisor for that activity, and be given to the appropriate systems development group for review or feasibility study. At this point, a Job Authorization is prepared for the job.

The feasibility study reviews the practicality of the job and provides an estimate of developmental time and cost. The JA is then referred back to the user department who must approve the estimate and authorize the undertaking. Project control of the systems and programming effort is maintained under a procedure which provides an accounting of professional time and computer testing expense in relation to the time and expense estimated for the completion of the job. In addition, the computerized accounting procedure gives management a comparison of the calendar time expended for the project in relation to the estimated completion date.

Incidentally, we provide guidelines for our professional staff in a standards manual which is divided into four sections. The first section covers Systems Design; the second Programming; the third Computer Operations; and the fourth covers Auditing and Control. The manual insures that developmental and operational activities follow efficient, uniform procedures, and permits maintenance support by personnel other than those originally involved in the project.

With further regard to system development, our professionals are generally divided into groups of about twenty persons under the supervision of a systems manager. Programmers in these groups use remote facilities from the computer center for developmental and test support. Terminals utilizing IBM TSO software are available to them for interactive testing, while batch testing with printed reports are available through RJE equipment.

All systems are distributed through the headquarters Central Library. Systems development groups provide source programs and documentation to the Central Library. Library personnel compile the programs and release executable code with documentation, including microfiche program listings to the field systems staff.

Systems are checked for compliance with standards and for completeness and accuracy of documentation prior to release to the field. Any discrepancies are resolved with developmental groups before the application is authorized for release from the library. Program problems that occur in the field are documented and reported to the library where appropriate records are maintained to insure that follow-up and corrective action is taken by the headquarters systems group.

After implementation of the system in the data center, the company unit or activity served by the system is charged for the ongoing operational costs. The computer centers operate on a break-even basis, and charge all costs of operation to clients or users of the data center. This accounting is accomplished by a computer program which makes a complete distribution of data center costs and produces a series of comparative reports for management review. These reports include unit cost comparisons for major applications such as the cost to process the billing system for each credit account, cost to process the inventory control systems for each item of inventory, etc. Another example is a report comparing resource cost of various components of the computer, such as cost per unit of work performed on DASDI, tape, printers, etc., as well as cost per CPU minute. These reports, produced under a uniform system of accounting are reviewed at the Territorial and Corporate offices with appropriate follow-up directed to those locations where the reports indicate unusual costs or operating results.

I should mention another aspect of control that is administered through our headquarters technical support group. This group exercises EDP equipment research responsibility for the company. Any new equipment or supplier is thoroughly researched and evaluated by this group before it is authorized for use in any Sears location. If the equipment and supplier are judged satisfactory for use within Sears, this group working through the Corporate Purchasing Office negotiates a national contract that outlines the terms and conditions for the equipment or services provided by the vendor. Field units may elect not to use the equipment, but they may not select another item or vendor unless it has also been so approved and a national contract exists. In addition, the field unit may not obligate itself to an item of equipment for more than one year. If a longer term commitment is required, the field unit must submit a request to the group which will secure the appropriate corporate approval for any lease term in excess of one year.

As I have indicated previously, we are very concerned about systems performance and the efficient operation of our computer equipment. In this connection, we have a small group of technically skilled professionals in our Technical Support Activity which maintains a rather complete library of software monitoring tools that can be used to identify bottlenecks in systems and validate recommendations for hardware changes. A great deal of effort is expended by this group in identifying inefficiencies in JCL, sorts, network parameters and the like.

To comment further about control, we have spelled out very literally the security requirements of our data processing operations. These instructions stipulate such things as computer room construction and fire protection requirements to include detection and Halon extinguishing systems. As you might expect, I cannot comment on the specifics of our personnel security and access control requirements.

Of course, data security is defined with strict control over the classification of data files and access control to tape libraries. Provisions for a contingency plan are also spelled out that insure that each data center has taken steps to provide for full recovery in case the data center should be disabled or incapable of operation.

I should also discuss the data center audits which are conducted by the Sears Internal Audit Department and/or by our outside auditors. These audits follow a rather formal outline and can last from two days to two weeks, depending on the detail covered and the amount of application audit involved. These audits check for compliance with company policy and corporate standards. In addition, they look for security problems and irregularities.

In addition, Operational Reviews are conducted for each data center periodically. These Operational Reviews are conducted by a data center manager from another field unit along with a member of the Corporate Staff. Usually, the review lasts three days and covers organization, administration, and all aspects of computer operations. These reviews have proven to be an excellent method of communicating new ideas between data centers, and improving the efficiency of our operations.

Up to now we have talked about policies, organization, management, and control. Perhaps we should take the last minutes of our time and talk about the results of all this. What has been done in Sears with the information resource?

Much of our early efforts in data processing were given to the catalog and warehousing side of our business and, accordingly, most of the information processing parts of this business are handled by computers today. Virtually all catalog orders are taken over the counter or by telephone in our selling units and transmitted through our communications network to regional computer centers where the orders are processed, priced, scheduled, and then filled for shipment to customers.

From this order data, inventory records are updated and maintained, and buyers are provided with merchandising statistics and sales forecasts for this business. This same order data is processed to our customer index file which is the basis for our catalog advertising and distribution process. If the order is a credit charge and has been approved through our Credit Authorization System, then it is charged by the system to the appropriate credit account. Of course, sales and accounting records are updated in the process.

I should mention that we are making increasing use of computers to control the materials handling operations of our distribution centers. Computers monitor tray, slat, and hanging sorters as well as the conveyors for transporting merchandise through shipping and receiving operations. As an example, computer controlled equipment eliminates most of the manual receiving, storage, retrieval, cutting, and shipping of heavy carpet orders in our Floorcovering Distribution Center in Chicago. In a somewhat similar way but for quite different merchandise, our new Fashion Distribution Center in Elk Grove, Illinois uses computers to control the movement of flat and hanging fashion goods through that distribution center.

Our business is retailing and, accordingly, a large part of our program has been given to this area. As you may know, we have now installed electronic registers and associated computer equipment in our retail stores. This equipment enables our salespeople to collect the information needed to support computerized systems for inventory control, payroll, accounting, and customer credit billing.

The primary justification for installing this equipment in our stores was to provide sales information for our retail inventory management system. But the equipment, particularly the small computers in the stores, is used for other purposes. Our retail accounting activity in the stores uses CRTs interactive with the store computer to handle the accounting and auditing function and to prepare the usual accounting reports for store use and transmission to headquarters.

As you would expect, we have a number of peripheral systems which support the two basic system structures involved for catalog and retail units. Our Credit Authorization System is used nationwide and, of course, credit sales and transactions are computer billed by our Accounts Receivable System. In another area, our service representatives, when taking a customer's phone call for repair service, can display on a CRT screen information about the customer's appliance purchases and service history, prepare the service order for the call, and update the necessary accounting records for the transaction. Of course, we use computers to process payroll and personnel information for the over 400,000 employes in the company.

We are heavily involved in the consolidation of data for use by territorial and corporate management, and this has brought about the development of over 3,000 computer programs or modules which are run for these purposes in our headquarters data center. Speaking of computer programs, we estimate that our library of computer systems contains about 8,000 program modules and represents several thousand man years of professional effort. I might mention that for a program of this magnitude, our total data processing expenditures last year for system development, maintenance, and data center operation as a percent of sales was considerably below the industry average for Fortune 500 companies.

In closing, I should emphasize the increasing importance of communications and data transmission in our information processing network. I must use the term "network" advisedly because today we serve Sears operations with a number of networks. One of our networks which we call our National Data Exchange network connects approximately 3,000 Sears locations and about 500 of our supplier or vendor locations. This network transmits our administrative telegrams, our catalog order and stock requisition volume, purchase orders between our stores and vendors, about 1,000 reels of mag tape files each day, and about 3/4 billion characters of store transaction data each day. Then we depend on other networks for credit authorization, customer service calls, and the like.

But our objective is to consolidate all our communication requirements into one network operation. Yes, one network that will effectively link every unit with every other unit of the company from an informational standpoint. By doing this, we can bring the use and capabilities of the computer and communications facilities to every segment of the company.

We have not yet completed such a network for Sears, but we are well underway in its development and implementation. As we complete these objectives we know that company activities and management will be better able to react to the dynamic requirements of the retail environment and will come closer to having the right merchandise at the right price in the right quantity at the right place for the always right customer.

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INTERNAL MANAGEMENT AND CONTROL SYSTEMS IN DATA PROCESSING

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The typical MIS/EDP Department has grown dramatically, has accomplished this growth with limited funds, and is continually hard-pressed to render services and produce tangible outputs. Many MIS/EDP managers have not taken the time to truly consider how they should properly operate their department. This paper identifies the internal management systems required for the effective administration and control of an MIS/EDP Department.

The abstract of this paper is included for the interest of the reader. Unfortunately, the full paper was not received in time for publication. For more information, please contact the author.

COST REDUCTION IN UNIVERSITY INFORMATION SYSTEMS: THE OPPORTUNITIES AND THE PITFALLS

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Computerized information systems are often installed to reduce costs. Frequently, predicted reductions are not realized; and sometimes costs are actually increased. This paper explains why. Three studies are presented that cover cost reduction projects in the areas of system design and development, teleprocessing, and user operations.

I. INTRODUCTION

There are generally three rationales for the creation or acquisition of new hardware/software systems. The first, which is not directly related to this discussion, is a mandated action -- a new or changed law forces you to modify your current practices as with the Buckley amendment, Affirmative Action requirements, or a collective bargaining settlement.

Secondly, it may be determined that, in order to fulfill its goals and objectives, the organization should be doing something that it currently is not doing or that an existing operation should be improved. One of the ways Unique University might do that is to install a data processing system to monitor each of its students. Now, that system is going to cost more than what you have, but it is going to enable you to do your job better than you are now doing it. The clerical cost of monitoring your student population properly without a data processing system would be astronomical, and it is these costs which are avoided.

As shown in Figure 1, there are three cost measures involved: X, which is the current cost; Y, which is the cost of doing the job properly without a new system; and Z, which is the cost of doing the job properly with a new system. The proper cost comparison then is Y vs. Z, not X vs. Z. This is a cost avoidance justification.

The third rationale is that actual cost savings -- to do the same job we are doing today, but save money doing it by installing a new computer system -- a new piece of hardware or software.

COST AVOIDANCE

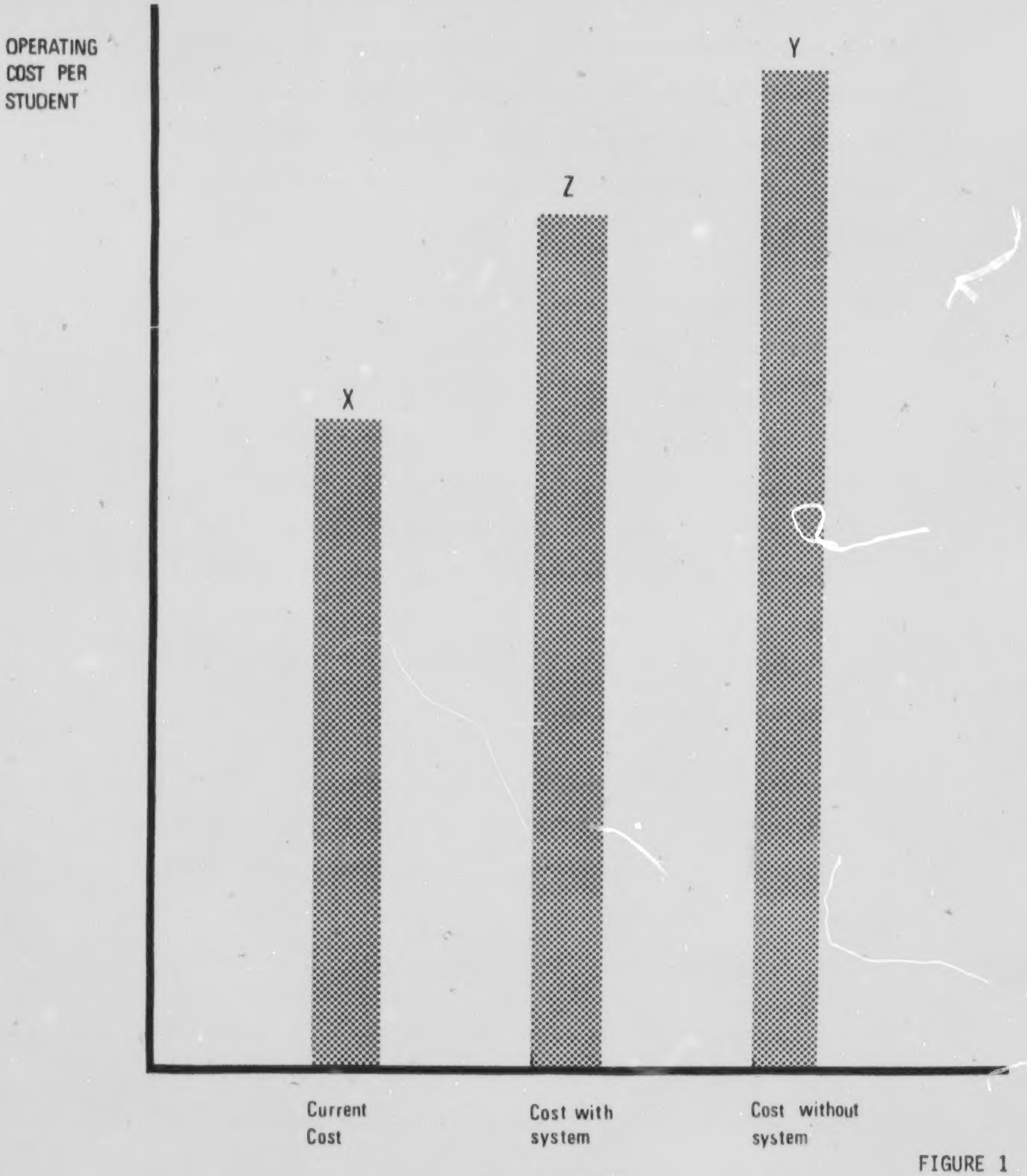


FIGURE 1

Justification for new or improved systems is most often a combination of cost avoidance and cost savings, but rarely is it so identified. This presentation covers areas where cost avoidance or savings might be anticipated as a result of new systems, some of the problems and pitfalls encountered and why they may not be anticipated, as well as some things that can be done to avoid the problems and pitfalls or at least be aware of them and their possible impact upon you.

II. ANTICIPATED COST SAVINGS/AVOIDANCE

An area often identified as a candidate for savings is that of system maintenance. Fewer man-hours will be needed for a given maintenance problem, because new techniques of higher level programming, structured programming, use of libraries and table-driven concepts, will all contribute to easier and faster maintenance.

Secondly -- and this is probably the most often used selling point of a new system -- much less system enhancement manpower will be needed to support a new system. Hopefully, any new system meets current and short-term projected user needs, so there is not a constant stream of requests to make system changes to meet today's environment. Those features should be built into the system from its conception.

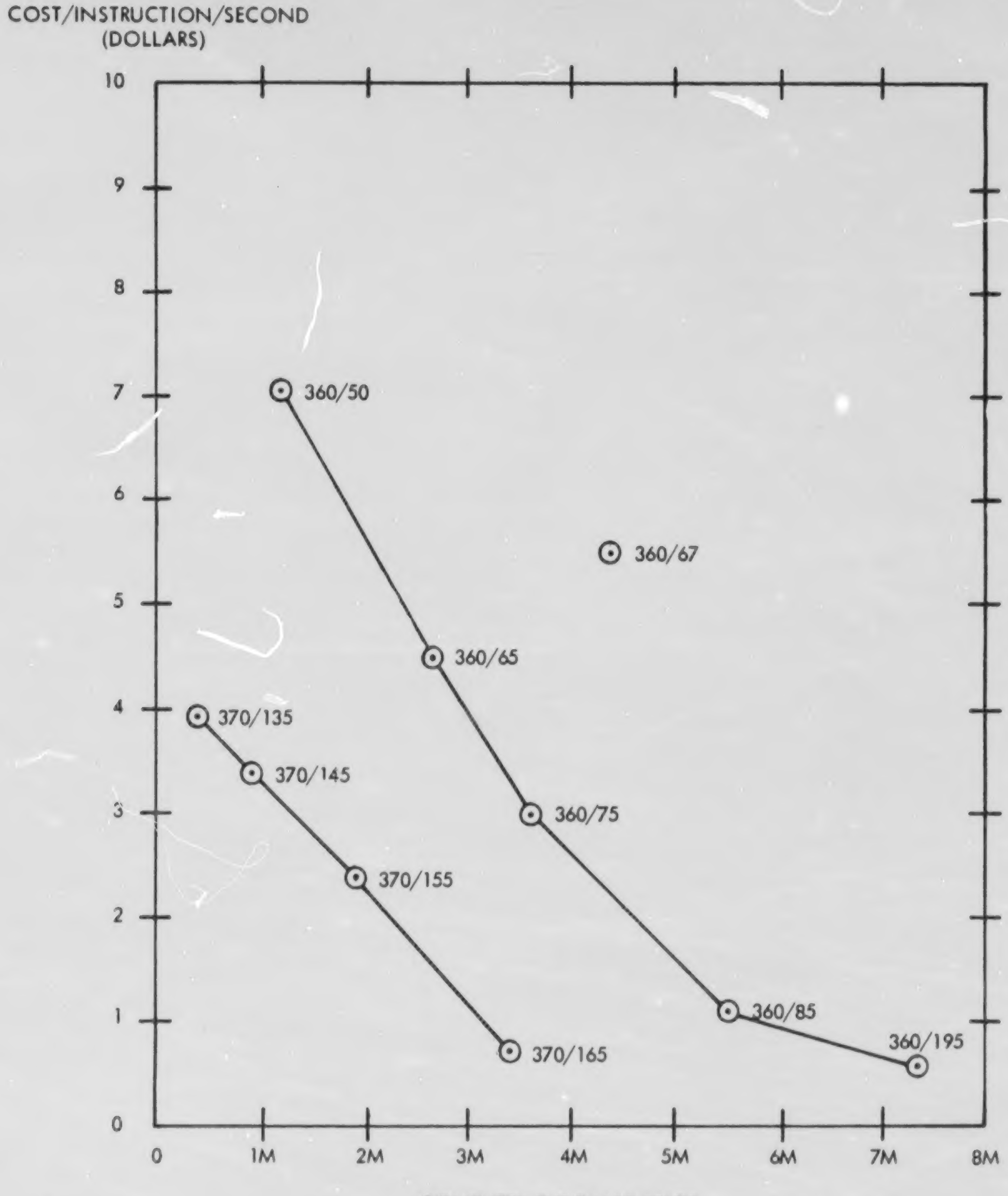
Another area of projected savings, particularly in the hardware area, is that of mechanical efficiency -- more "bang for the buck." While a clock-hour of time on a newer large computer has a greater base cost, you can do much more in that time than you can on your current machine. An institution providing on-line add/drop services for its students, for example, may be able to do five times as many add/drop operations in an hour on the new machine as it could on the old. Even if the new computer costs three times as much to lease, it is therefore obvious that the cost per add/drop is much lower. An illustration of the declining costs of hardware which are occurring with a growth in efficiency is shown in Figure 2.

A fourth area of projected savings appearing in many proposals for new systems is that of replacing personnel costs with machine expenditures (see Figure 3). Historically, "people cost" -- salaries, fringe benefits, etc. -- have been dramatically increasing while, as mentioned above, machine unit-costs have decreased.

The last general area of projected savings has been in the area of supplies and support services. Replacing paper and print time with microforms or on-line facilities; reducing file folders, cabinets, and office space (which, by the way is a major overhead cost item, often overlooked), replacing key-data operators with point-of-origin data capture -- all of these can save significant expense in the overall operation.

III. PROBLEMS AND PITFALLS

There are many common problems and pitfalls encountered in cost savings/avoidance attempts. Those of us in systems and the users who have been dealing with us over the years are well aware that our promises-to-performance ratio has not been very good. There are, I believe, two overall reasons for that. The first relates to simply not realizing the anticipated savings of which I have just spoken; the second is



Cost Effectiveness of Computer Families (IBM Computers).

FIGURE 2

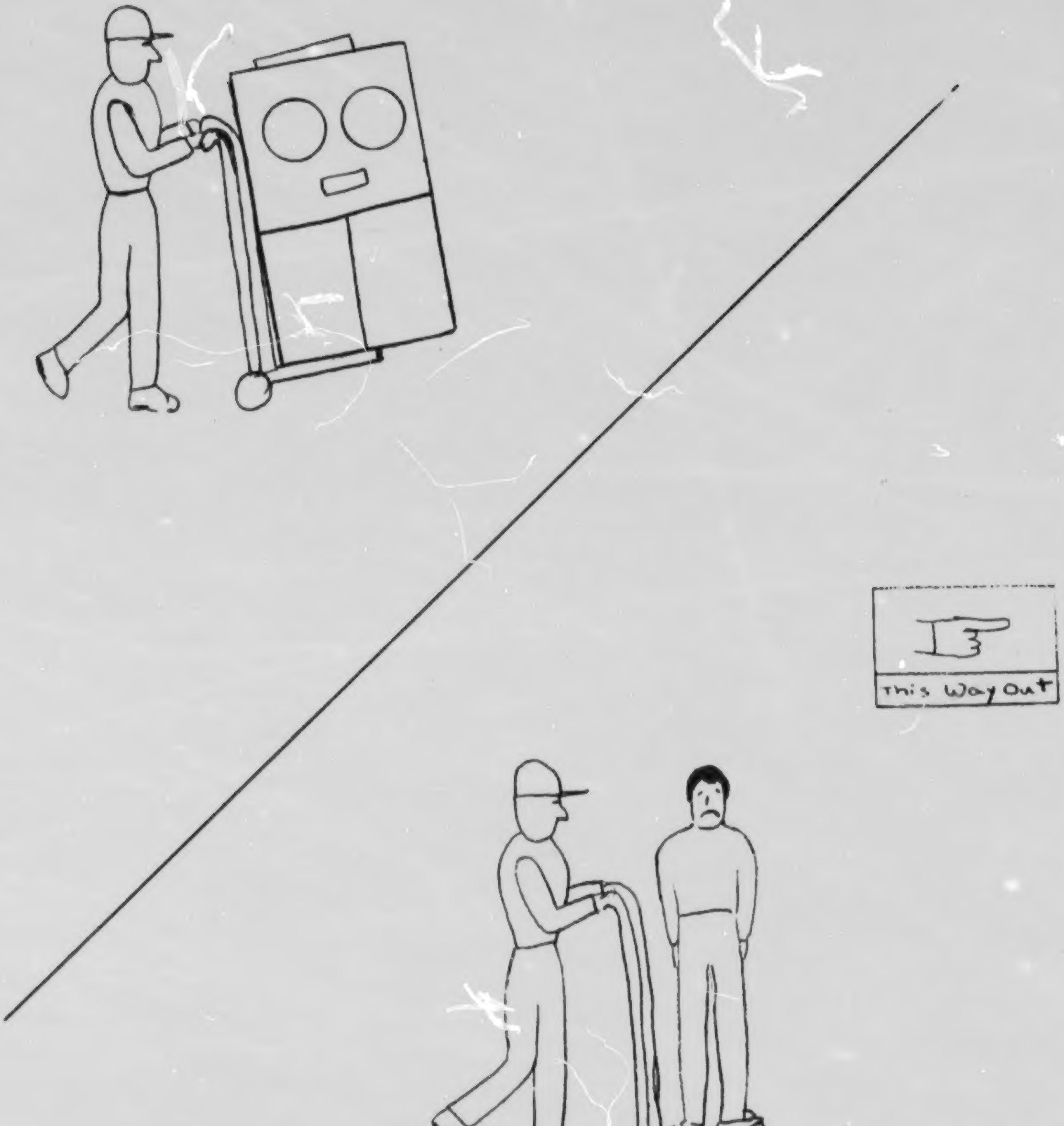

This Way Out

FIGURE 3

that completely unforeseen occurrences and costs arise when and after a new system is installed -- for instance, the mandated changes mentioned above.

Often, anticipated maintenance savings go down the drain when it becomes apparent that the new software you have acquired -- IMS or a SUPERDUPER Financial Aid System -- is going to require talented and expensive specialists to see to its care and feeding (see Figure 4). An experienced and capable state-of-the-art software expert is going to cost you a lot more than a COBOL programmer trainee. This situation quickly worsens, because the work produced by these specialists can only be maintained by others of their ilk. It is hard to find a programmer who is blase in the face of a change required for a program which contains 16 levels of nested IF's. So you have to hire more expensive people or train your current personnel in the new techniques and then pay them accordingly lest they and their newly acquired skills flee to greener pastures. Another more subtle effect of establishing a highly specialized staff is the loss of flexibility in assigning resources and the disappearance of cross-training and transfer opportunities; all of which can result in a need to expand the staff overall. In any event, the end result is that, while fewer maintenance hours need be spent, each hour is significantly more expensive.

The area of system enhancement is probably the area where unexpected costs and unachieved savings most frequently occur. There are two main reasons for this. The first is that, on a major systems effort (1 - 3 years), the functional specifications are constantly evolving --

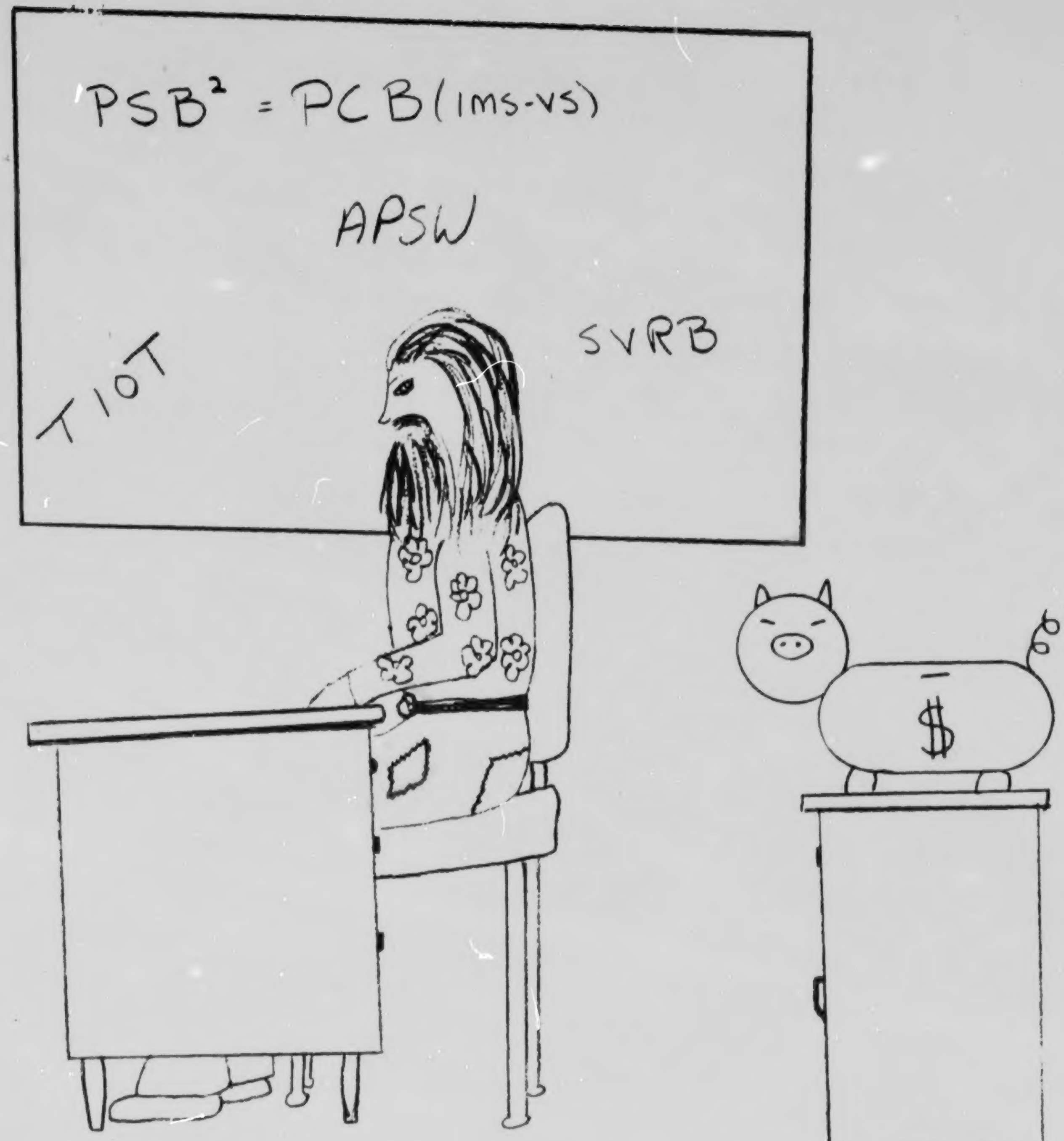

PSB² = PCB(ims-vs)
APSW
TIOT
SVRB
$

FIGURE 4

there are legitimate changes in the user operation which occur between the day the system is designed and the day it is installed. Rarely does a project plan include the time or resources necessary to deal with this phenomenon. Secondly, one invariably encounters Navarro's Law of Data Processing -- "Today's luxury is tommorrow's necessity", and its corollary, "Every day a new demand". User needs will expand and fill to overflowing the capabilities of a new system from the day it is operational. Sometimes it is justified, sometimes not, but it always happens.

A newly-installed system may contain 27 standard reports which, according to the feasibility study and the system design, will fulfill 98% of the user's information retrieval needs. To cover the rest you include a Random Report Generator to be used in semi-emergency cases. Well, these semi-emergencies suddenly begin to occur three times a day, and the run costs of the RRG, which might be inherently inefficient or misused due to hazy specifications typical of emergency requirements, are forcing you to buy time to run the payroll. The net effect of this growth in user requirements is illustrated in Figure 5. Moreover, special COBOL report writers are produced like crazy, and your enhancement costs skyrocket, as will your future maintenance costs.

More "bang for the buck" savings are difficult to realize, because the first new system to need a facility (IMS DB/DC for instance) is often charged for its acquisition, even though it does not need all of the facility. Then, too, interfacing requirements will often force a slowdown of production.

EXPANDING "NEEDS"

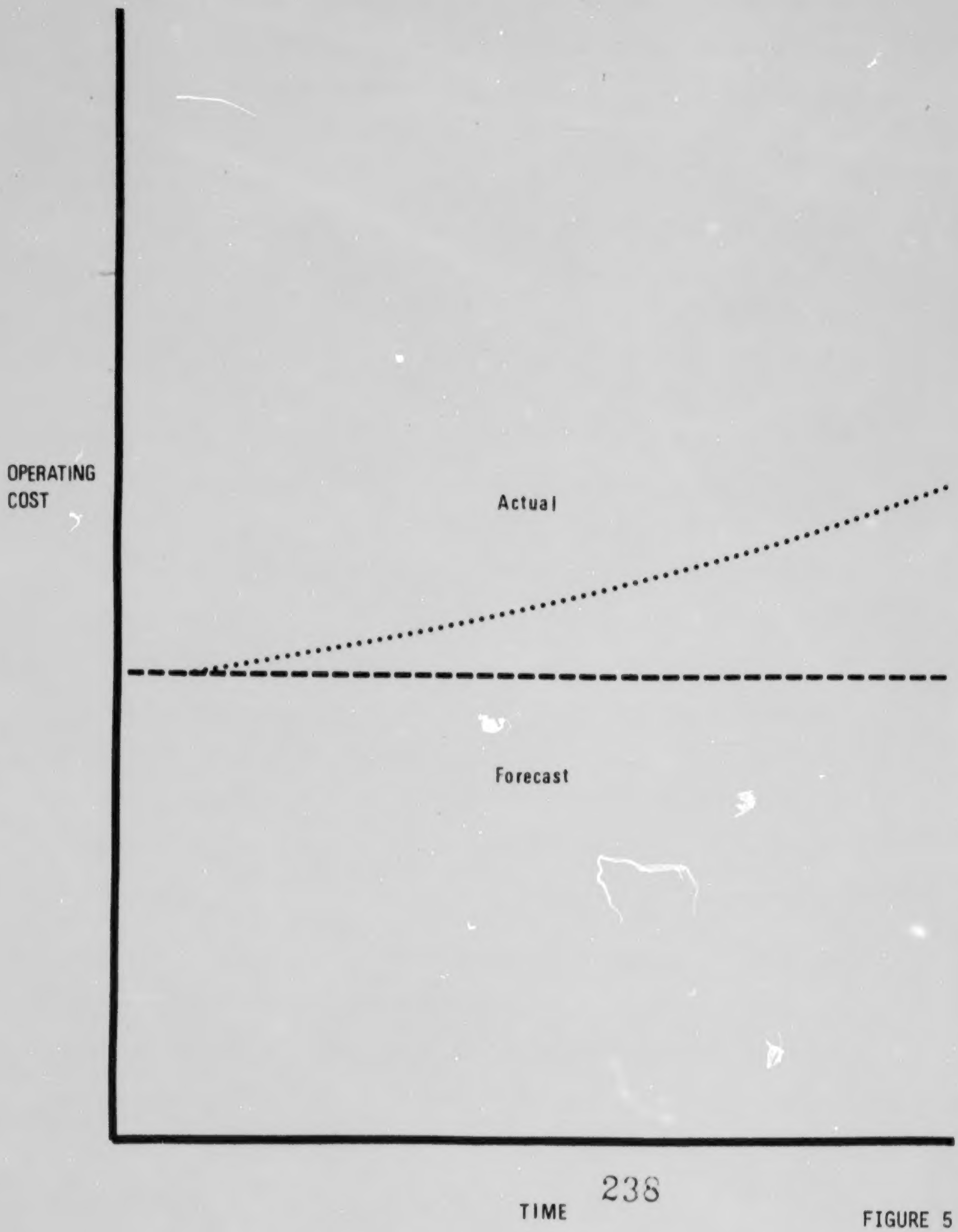


FIGURE 5

The personnel savings which are glowingly touted at proposal time never quite seem to be realized. Except in rare cases, personnel are not eliminated. In the real world, they are at best replaced. A need for a clerical position may be eliminated by a new system, but the same system adds a key entry operator to the data processing staff. Such re-assignment is almost always toward higher-priced positions. A sorting-bursting clerk becomes a data control specialist. A programmer becomes data base administrator.

Supplies and services saving? Forget it. Users are uncomfortable with data they cannot see, touch, and taste -- "... but I can't write on microfiche". Also, the first system outage or downtime results in anguished cries for hard-copy backup with the associated costs of redundancy (see Figure 6). Here again, Navarro's fifth law operates -- the user who last year made do with weekly batch file update and printing now cannot possibly exist if his terminal is down for a half hour. This results in great pressure for redundant, hard-copy backup or redundant hardware.

Midway through the project, not only do you find your savings projection being chipped away by all these factors, but a host of unforeseen and unplanned for budget-eating dragons also rise up and attack you.

One of the most common things you find is that you did not pay attention to your curves. We all know about learning and error curves. When we estimate system thruput, do we count the transactions that have to be re-done because of errors? Do we guesstimate clerk time

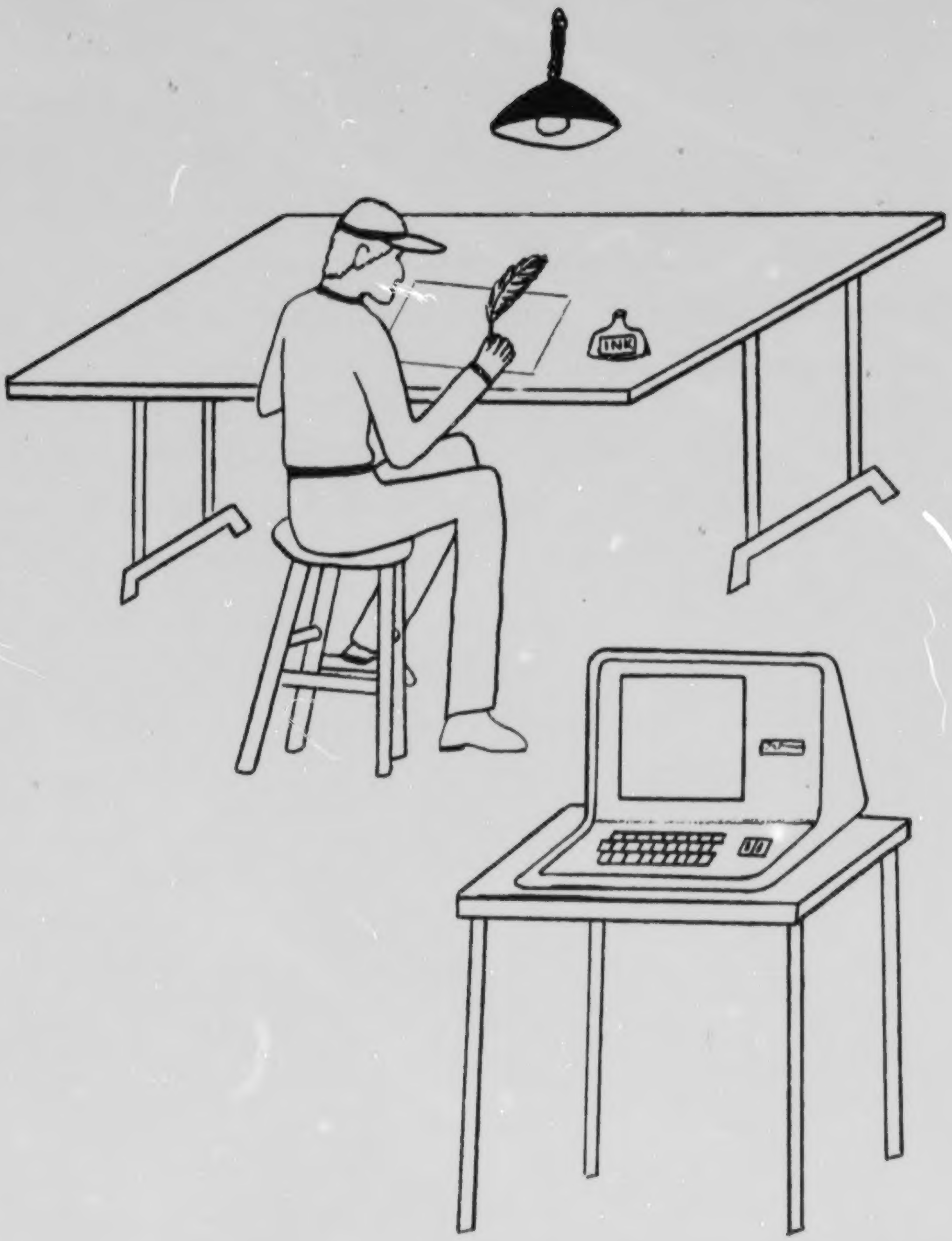


FIGURE 6

by how long it would take us to do the job? Probably. Should we estimate that way? Learning rates have a profound impact on the effective use of a new system whether in the transaction error rates, as illustrated in Figure 7, or in the capabilities of readers to understand and utilize a new management report.

Are we aware that a prompting feature, so vital in a new interactive terminal system, will become a time waster which is irritating to the point of physical violence after the user has worked the system for a while? Sure we are.

What about the design mistake dragon, otherwise known as "But I thought you meant ...", which results in re-design, re-programming and re-testing. Programmers/analysts are human.

How about peripheral support of both the user and the system development team? Did the original proposal or plan include costs of electrical power, air conditioning, telephone, security, etc., etc.? Systems do not run in a vacuum. Project team members need clerical and administrative services. Does the plan for the new system realistically allow for computer time and transcription sufficient to carry the system through a thorough testing cycle? Are there provisions of your time and that of the users for training, procedures development and check-out, review meetings, parallel staffing, conversion, design and specification evaluation, and the myriad of other people-consumers?

Finally, there are the external factors over which we have no control. Information systems are all to one degree or another designed to fit the functions of various components of the institution. What happens

LEARNING EFFECTS

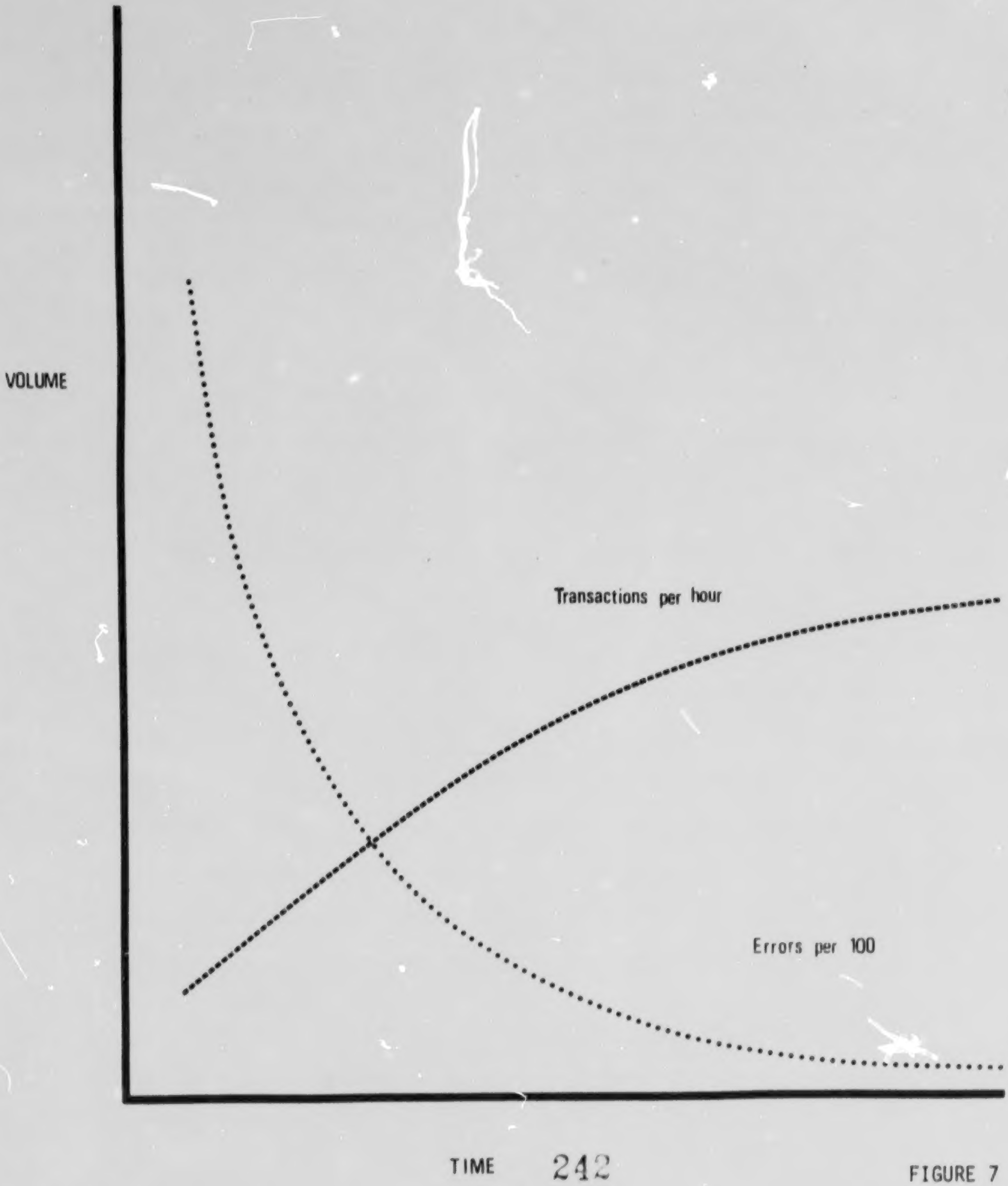


FIGURE 7

if there is a reorganization and those functions are distributed differently? What happens when a vendor, who has won a software development contract with a low bid, defaults and disappears? Can you get the job done for the same price? It is not likely. A view of the cumulative effect of these various cost factors is presented in Figure 8; the overall costs for a system are portrayed over the long term.

IV. WHAT TO DO

Now that I have scared everyone off from attempting any new systems effort, what next? Well, users do some things and we do some things. Now that the majority of the cost inducing dragons have been spotted, what can we do to stay out of their territory?

Users need to be realistic and real-worldish about their functional needs. Be cost aware of what the new system should be asked to do. Bob Townsend said that "Systems are like roads. Very expensive. And no good building them until you know exactly where they're going to wind up."[1] Know where you want to wind up. Programmers, analysts and DP managers are not infallible gods. Ask questions. If you went to a doctor because of a minor pain in your stomach, and he told you that you had an ulcer that needed immediate surgery, would you let him whip out a scalpel and commence slicing right there in his office? Do not let your technical staff cut you up at will. Ask these folks questions about their proposed solutions to your problems. Justify those solutions.

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[1] Robert Townsend, UP the Organization, Greenwick, Conn.: Fawcett Crest Book, p. 19.

COST SUMMARY

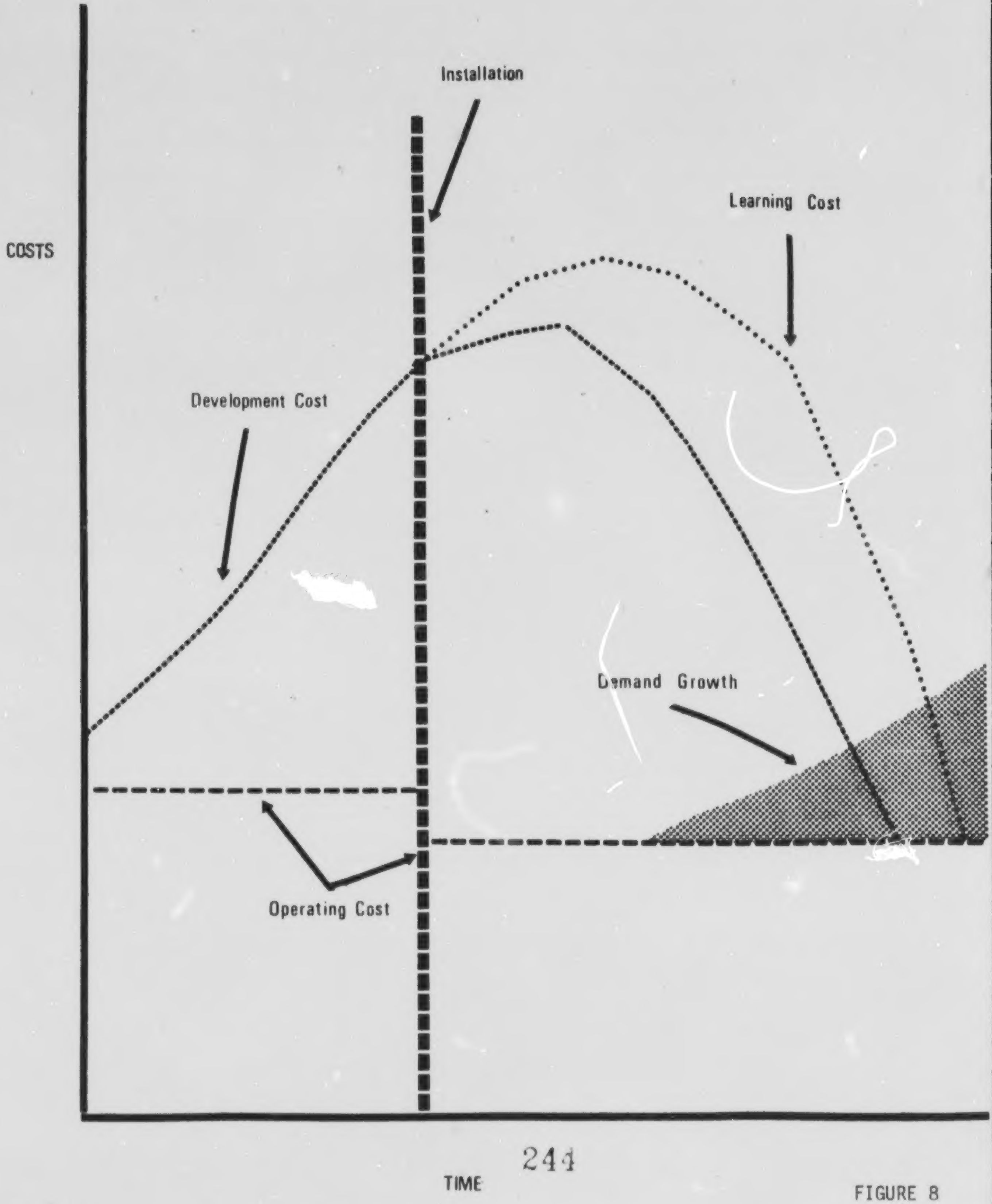

FIGURE 8

Try not to get spoiled. An on-line real-time computer system probably generates more neuroses than a minor war:

- It is impressive. Look at those figures march across the screen. Look at this huge hulking monster who is at my command. Isn't it wonderful.
- It works. Things get done. It's so dependable. I can really depend on this system. Why, I trust it with my life.
- It gives me prestige. Bob Smith may have his unlimited expense account, Sadie Jones may have a Bigelow on the floor, but I have the latest in computer systems. Eat your hearts out.

Now comes the day when I press the attention key until my finger bleeds and there is no response. The call goes to the system analyst and, whatever the words, the message is clear -- "If this system does not come back up immediately, the world will end!!!" (See Figure 9.)

In reality, of course, from a completely rational point of view, you can probably do very will with a certain amount of systems failure. Many terminal vendors, for example, will contract to have a malfunctioning unit repaired or replaced within four hours of your service call. Is saving that four hours of lost time really worth the lease or purchase of backup equipment, or the constant production of reams of redundant reports?

And what should we sorcerers do? Working with users we need to be much more realistic in terms of our professional needs. Cast a hard eye on time estimates. Programmers, in the excitement of getting software to work, forget every other test shot. If you have not done any major systems installations lately, 500 or more man-days are required -- recall that there is a drastic difference between large maintenance

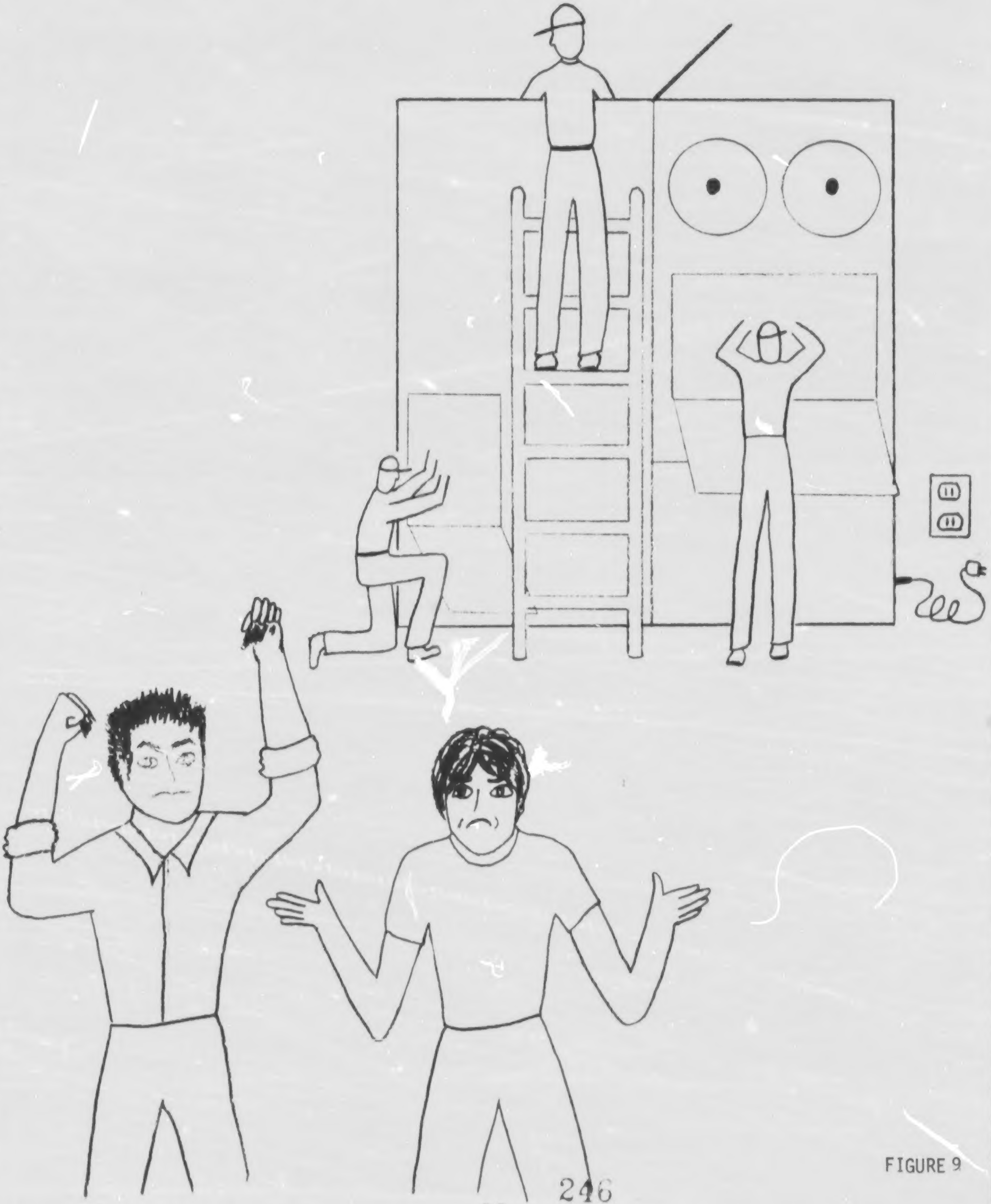

FIGURE 9

or enhancement jobs and a new design and development; moreover recognize that a whiz-bang maintenance analyst may be the worst possible personality to design and install a totally new system.

Include many review points in a project plan, not only for post performance of the project team, but also to rethink and confirm specifications.

Be careful when talking about future plans. A typical conversation goes:

> Irving User -- "Say, by the way, could this new system forecast enrollment profiles?"
>
> Sam Analyst -- "Sure it could. Piece of cake."

Those were the direct quotes. Asked for a repetition of the conversation, the versions would most likely be:

> Irving User -- "I asked Sam if the new system - you know the one, the student system which will be installed next month - would be able to forecast enrollment profiles right away, and he said it definitely would do that."
>
> Sam Analyst -- "Oh, Irv wanted to know if we could possibly add on an enrollment profile forecasting subsystem at some future time, and I told him that we could easily begin to plan that kind of enhancement."

Be very clear when talking about system capabilities.

Next, try to amortize hardware, software, and operations costs over applications and over time. Remember that a lot of mileage, some of which you can not now even envision, will be realized from components you install now.

Have professionals cross-check one another. In order to do this kind of mutual constructive criticism, you must have a team that respects one another; the individuals must be mature enough not to identify their personal worth with the work they create (see Figure 10). The effort you put into building this kind of team will pay multiple dividends in the future. Use of the new structured design and programmer team techniques are useful here.

This brings up another point. When evaluating project control tools and methodologies, remember that each of them has a specific goal and rationale, and was probably developed with a particualr set of criteria in mind. Thus CPM, developed by Remington Rand for a project they installed for Dupont, concerns itself with costing at design time; PERT, created by Booz Allen for the U.S. Navy's Polaris project, is primarily concerned with time and looks at cost only in retrospect; HIPO, initially used by IBM's Systems Development Division, is strongest in supporting increased efficiency of professional resources. You must fit the tool to your situation -- using a project control system developed elsewhere "as is" without tailoring it would be as disasterous as installing another institution's accounting system "as is" and expecting it to run glitch-free.

Systems are said to fail for one or more of the following reasons;[2] each of which can, instead of failure, lead to deteriorating cost

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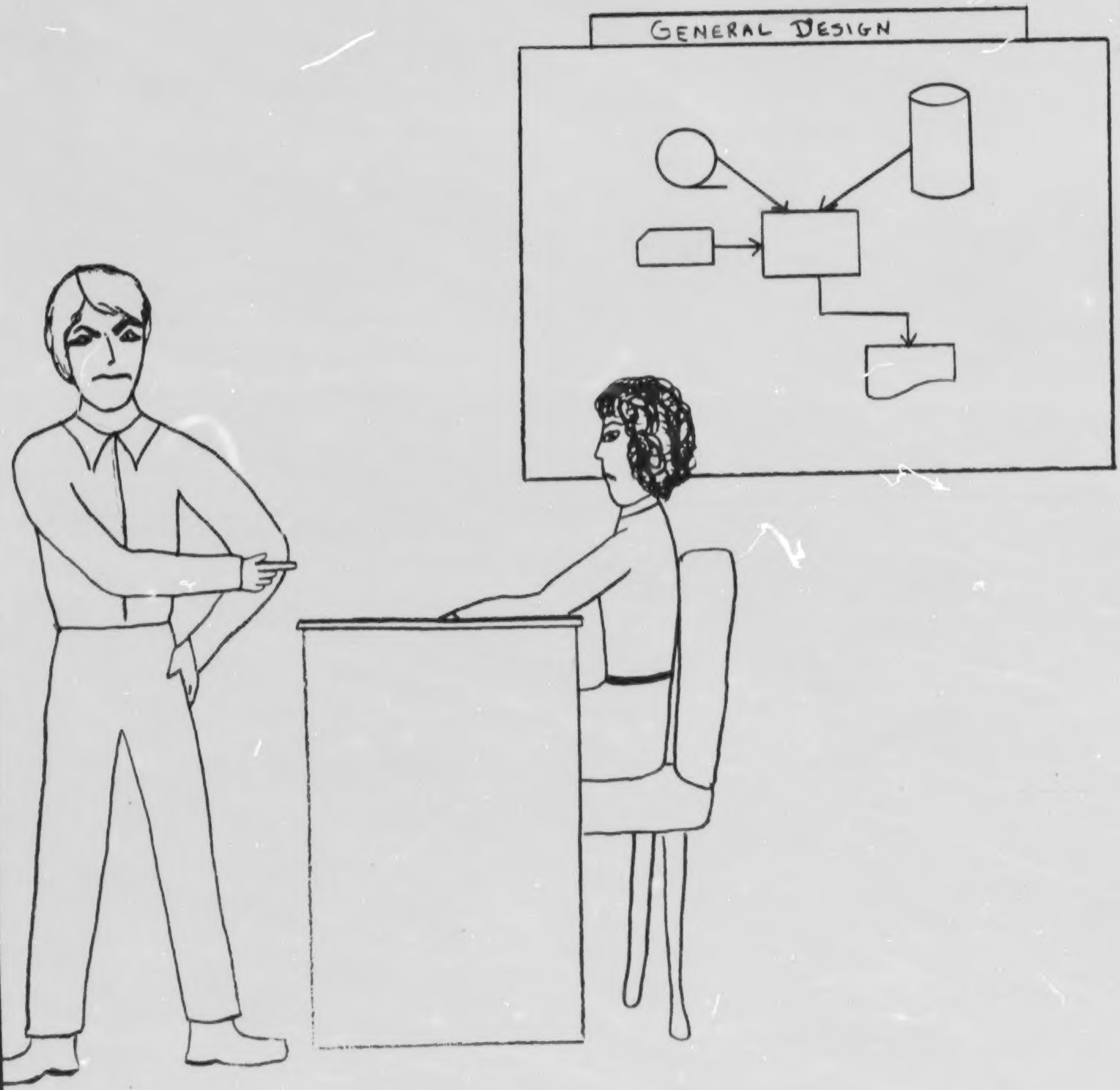
[2] Understanding MIS Failures, Proceedings of the Wharton on Research on Computers in Organizations, H.L. Morgan and J.V. Soden (Philadelphia, Pennsylvania: 1973).


GENERAL DESIGN

J'ACCUSE!

FIGURE 10

effectiveness.

- Operational Failure
  (The system does not do what the user needs it to do often because neither the user nor systems can agree on what that is.)

- Economic Failure
  (The system does not - for sociopolitical or other reasons - address real cost savings potentials.)

- Technical Failure
  (A prime example of this is a system utilizing highly sophisticated tools which runs too slow to meet the required production schedule - tuition bills come out with term grades.)

- Development Failure
  (The effort to develop the system exceeds time or dollar budgets or both and thereby so increases the total cost that the return on investment disappears.)

- Priority Failure
  (The wrong sequence of development is followed so that excessive costs are incurred and/or cost savings opportunities are lost or delayed.)

In order to avoid failure or, more typically, diminished effectiveness a new system installation must be intelligently planned, realistically estimated, carefully implemented, and closely monitored; in a word, new systems do not happen they are managed into being by persistent effort.

ADMINISTRATIVE DATA PROCESSING:
TEN YEARS LATER

John W. Hamblen
Chairman and Professor of Computer Science
University of Missouri
Rolla, Missouri

The National Science Foundation supported 1966-67 Inventory of Computers in U.S. Higher Education included a check list of administrative processes for which the respondents indicated the method of processing being used. This paper uses recent data to show the changes which have taken place and to what degree. A look into the future impact of new technologies on Administrative Data Processing are also given.

ADMINISTRATIVE DATA PROCESSING - TEN YEARS LATER

John W. Hamblen
University of Missouri - Rolla

Background

In May 1967 a contract was awarded by the National Science Foundation to Southern Regional Education Board (SREB) to plan and conduct an inventory of computers in U. S. Higher Education. A questionnaire was mailed to the 2500 institutions of higher education listed by the U.S. Office of Education. Responses were received from nearly 2000 of these institutions. Summaries were reported by Hamblen[2]. The survey instrument consisted of five parts with the fifth dealing with administrative data processing. Hamblen's[2] report was prepared under another contract, which was awarded to SREB in February 1970. This contract also provided for the compilation of another inventory of computers, their utilization and related degree programs in U.S. higher education, for the academic and fiscal year 1969-70. However this time the administrative data processing portion was excluded. Summaries similar to those reported by Hamblen[2] were prepared for publication by the National Science Foundation in June 1972[4]. In both cases summaries on a state basis were prepared but not published.

In order to provide continuing access to these data files, they were moved from the Southern Regional Education Board in Atlanta to the University of Missouri - Rolla in August 1972 when the Computer Science project director at

SREB moved to Rolla to become Chairman and Professor of Computer Science at UMR. NSF Grant EC-37530 was awarded to UMR in March, 1973, for "Conversion and Maintenance of Data Files on Computers in U. S. Higher Education" and another grant was awarded in June 1975 for the conduct of a fourth inventory of computers in U. S. Higher Education. It was hoped that preliminary data on 1975-76 would have been available by December, 1976. However, bureaucratic complications arose which caused a one-year delay in getting forms cleared by the Office of Management and Budget. The portion on administrative data processing has been reinstated and the items changed to agree with the Program Classification Structure published by the National Center for Higher Education Management Systems (NCHEMS). The actual list was provided by Charles Thomas, Executive Director, CAUSE, and a consultant to the Fourth Inventory of Computers in Higher Education (FICHE) project.

The three previous reports primarily consisted of straightforward tabulations and extrapolations with little or no interpretation. This was left to the readers. There will be two publications for the 1976-77 inventory. The first is to be comparable to the 1966-67 and 1969-70 publications and the second is to be an interpretative report that will follow the first as quickly as possible.

Expenditures

Projections made from past inventories[4] indicate that computing expenditures in higher education may be in excess

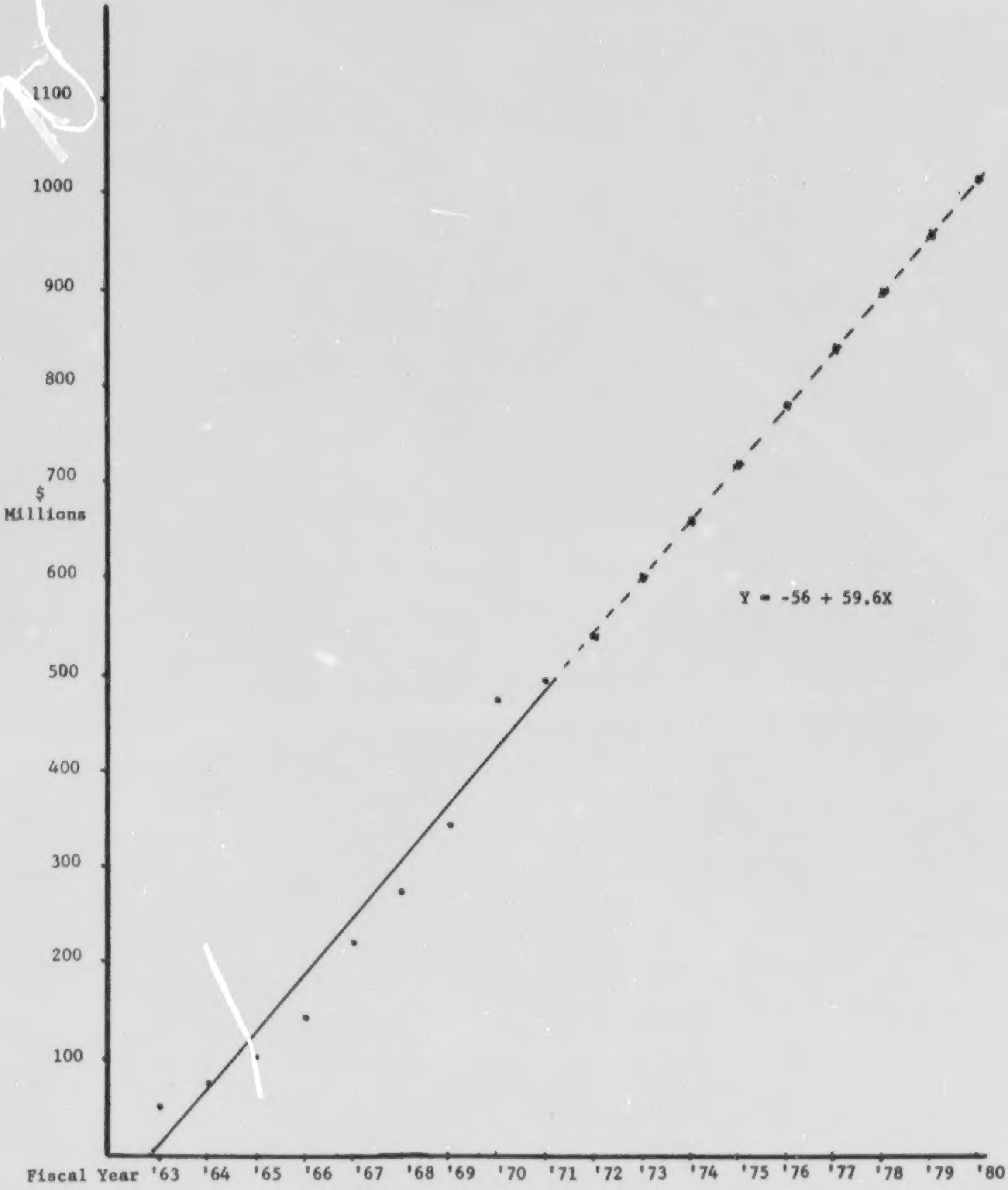


Figure 1

Estimated Total Expenditures for Computing in U.S. Higher Education 1963 through 1980

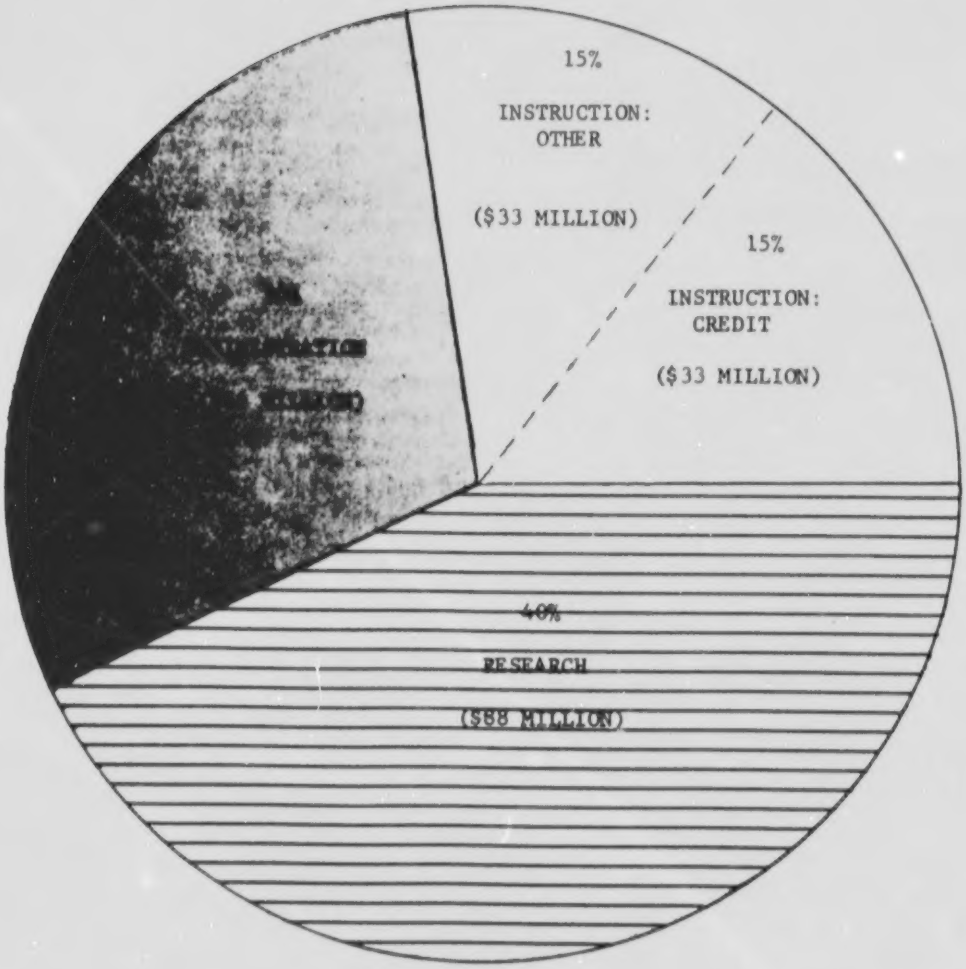


Figure 2
Estimated Distribution of Expenditures for Instruction, Research and Administrative Uses of Computers in U. S. Higher Education, 1966-67.

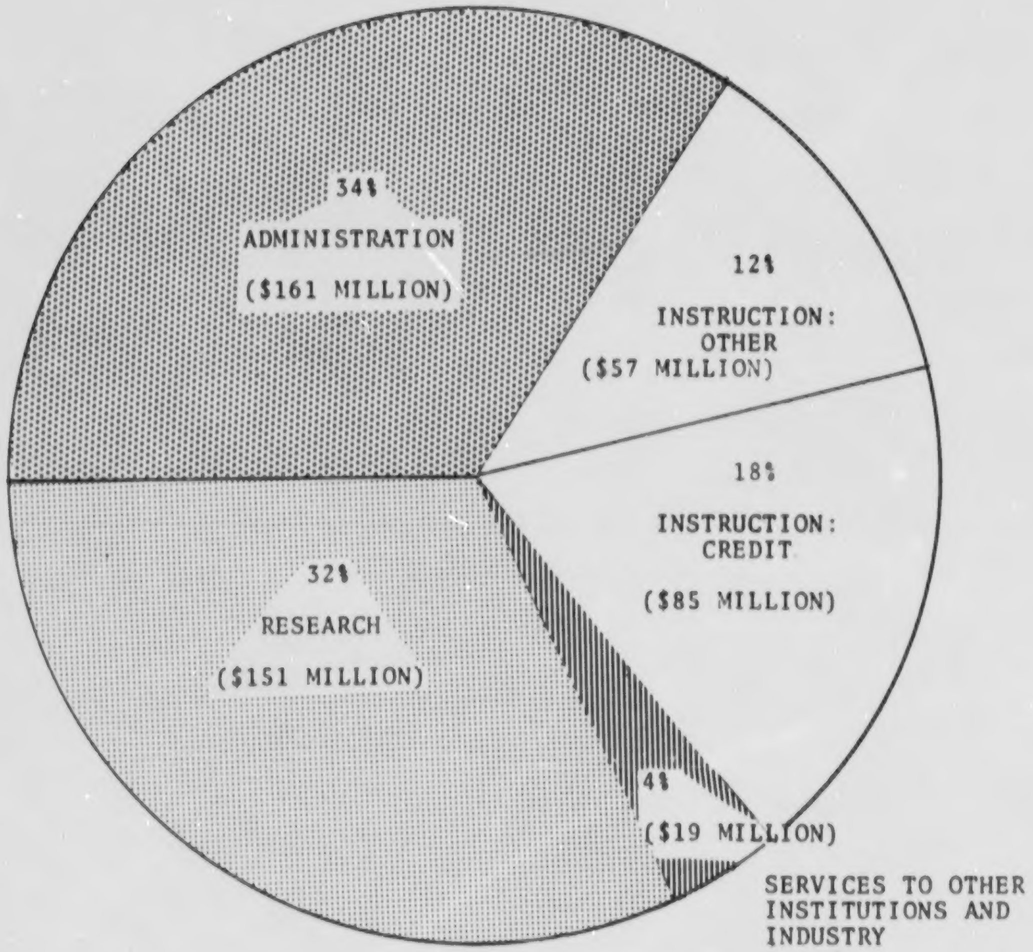


Figure 3

Estimated Distribution of Expenditures for Instruction, Research and Administrative Uses of Computers in U. S. Higher Education, 1969-70.

of 800 million dollars for 1976-77 (see Figure 1). It is not surprising then that Federal agencies, State legislatures, State governing and coordinating boards, and administrators of the individual colleges and universities are hungry for data on this seemingly ever expanding facet of higher education.

One of the expected changes in computer systems is the increased involvement with networks, and another is the more extensive use of the mini-computer as a sole facility for the small college and as a supplemental facility in a larger institution.

The percentage of expenditures for administrative uses increased from 30% in 1966-67 to 34% in 1969-70. The dollar amounts were 66 million and 161 million, respectively, (see Figures 2 and 3). For 1976-77 the percentage may be as high as 40% or in excess of 300 million.

Pervasiveness of Computer Usage for Administration

Approximately three out of four of the college and university computer installations are doing some administrative data processing (see Figure 4). Grade reports and class rosters top the list (see Table 1) of administrative applications being run on the computer. Table 2 is a copy of the complete summary of status of machine usage for administrative applications in 1967. A similar summary will be available for 1977 but the application titles will conform to the NCHEMS PCS titles. The "on-line" figures are probably

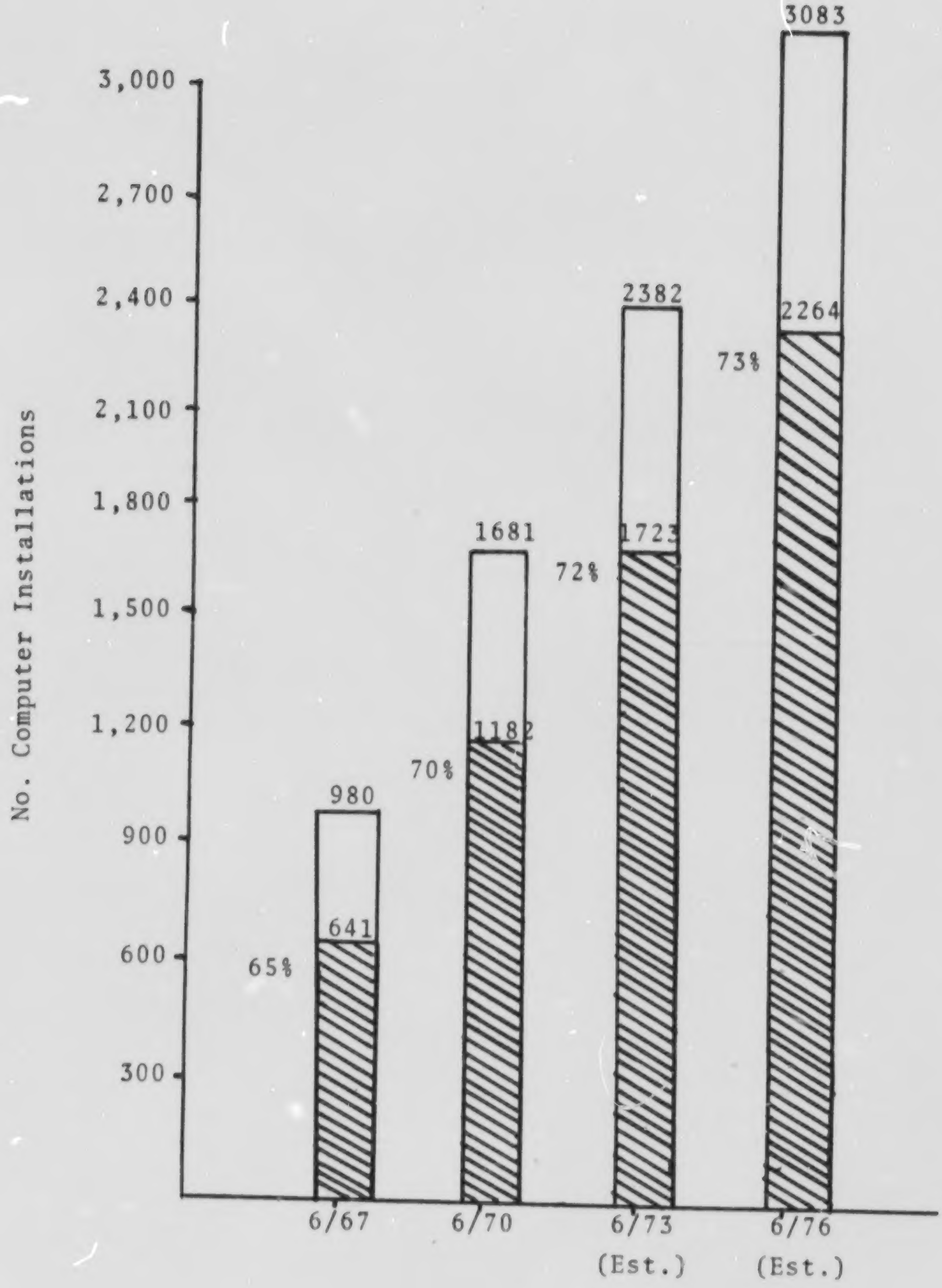


Figure 4

Percentage of Computer Installations Doing at Least Some Administrative Data Processing

TYPE OF COMPUTER USE	BATCH (%)	ON LINE (%)	1966-67 COMPUTER (%)	EST. 1976 COMPUTER USE (%)
Term-Grade Reports	60	3	63	73
Cum. Grade Reports	55	3	58	72
Class Rosters	54	3	57	72
Salary Payroll	43	2	45	60
Honors Lists	42	3	45	72
W-2 Statements	42	2	44	60
Hourly Payroll	41	2	43	60
Payroll Distribution	39	2	41	60
Probation Lists	38	3	41	70
Mailing Lists	37	1	38	70

Table 1

The Ten Administrative Functions Most Common on Computers During 1966-67 and Estimated Percentages for 1976.

	MAN-UAL	BOOK-KPG MCHNE	LEDGER ACC	EAM	BATCH PROC	ON LINE		MAN-UAL	BOOK-KPG MCHNE	LEDGER ACC	EAM	BATCH PROC	ON LINE
**********PAYROLL AND ACCOUNTING**********													
ACCOUNTING RPTS	363	93	49	83	224	2	ACCOUNTS PAYABLE	264	246	91	82	192	1
ACCOUNTS RECVBLE	243	267	101	91	179	3	ACCRUED SAL REPT	266	102	36	62	224	8
BUDGET PREPARATION	614	45	26	56	150	4	CHECK DEP SERV	524	39	24	18	64	
CHECK RECONCIL	567	21	16	71	163	1	DEDUCTION REG	175	109	35	75	301	13
EARNINGS STMNT	214	123	35	76	317	17	FOUNDATION ACCT	241	96	57	37	86	1
GEN DEPT ACCT	238	226	89	79	210	4	GEN LEDGER ACCT	250	270	117	75	181	3
HOURLY PAYROLL	242	133	40	73	363	19	INCOME CONTROLS	299	153	73	51	131	3
INVEST + ENDOW ACT	410	56	44	22	59	2	NOTES RECVBLE	348	97	60	30	62	
PAYROLL CONTROL	246	166	52	79	276	15	PAYROLL DIST	238	136	47	94	347	19
PENSION/GROUP INS.	315	98	45	58	260	15	SALARY PAYROLL	162	194	56	83	387	21
STUDENT LOANS	464	131	70	57	129	4	VENDOR/REMITT ST	357	127	40	53	109	2
WORKMENS COMP	404	43	23	15	97	4	W-2 STATEMENTS	265	100	25	93	375	18
**********ADMISSIONS, RECORDS, STUDENT AFFAIRS, ALUMNI **********													
CHK STU ADM REQMNT	747	2	2	40	87	4	PROC ADM APPLIC	613	4	2	111	185	5
STU HOUSING + FOOD	515	22	15	91	107	2	BLD MAST SCHDULE	652	2	3	58	147	6
ASSGN STU SECTIONS	640	2	2	65	152	13	CHK STU SCHEDULE	685	1	1	33	90	10
ATTENDANCE RECORDS	597	2	1	43	50	3	STU DIRECTORY	358	2		166	323	14
COMP AIDED COUNSEL	107		1	10	77	2	CLASS ROSTERS	238	8	4	241	486	26
TERM GRADE REPTS.	242	6	4	197	535	31	CUMM GRADE REPTS	269	5	2	145	495	26
DISMISSAL LISTS	485	2	2	72	251	15	HONORS LISTS	408	4	2	132	374	23
PROBATION LISTS	435	3	2	109	344	23	SUSPENSION LISTS	470	3	2	80	248	15
CHK GRDUATN REQ	749	2	1	32	76	1	GRADUATION LISTS	603	5	3	99	176	4
STUDENT PLACEMENT	686		1	9	40		ALUMNI RECORDS	496	7	3	99	183	4
ALUMNI DIRECTORY	410	10	1	79	159	4	ASSIGN FAC SECTN	745		2	10	24	2
********** ADMINISTRATION, INSTITUTION PLANNING AND RES & DEV,**********													
OPER COST ANALYSIS	545	33	16	24	101	3	BUDGET ANALYSIS	539	45	9	36	131	4
FAC CHAR ANALYSIS	584	4		27	108	2	STU CHAR ANALYS	409	6		67	226	9
PERSONEL UTILIZATN	505	2		18	80	2	SPACE UTILIZATN	532	3	1	36	153	3
RESEARCH MNGT	309	4	3	6	37		PROJECT MNGT	302	10	4	5	27	
SALARY STUDIES	538	9		27	132	4	MAILING LISTS	279	26	2	200	331	12
TELE DIRECTORIES	379	4	1	64	177	2	FACILITIES INV	450	8	3	72	160	5
LIVESTOCK INVENTRY	81	1		3	16								
********** LIBRARY MECHANIZATION**********													
ACQUISITIONS	660	9	8	12	57	2	INFO STORAGE	553	1		4	21	4
INFORMATION RETVL	539	2		3	17	4	CIRCULATION CONT	649	3	1	17	[illegible]	4
SELECTIVE DISSEM	460	1	1		12		QUEST AND ANS	453	2		2	[illegible]	2
********** MEDICAL RECORDS **********													
PATIENT-HEALTH REC	391	2	2	7	23	1	PAT-BILLING REC	222	25	2	9	31	3
CLINICAL RECORDS	337	2		4	14	2	DENTAL PAT REC	149	1	2	1	4	

Table 2

Status of Machine Usage for Administrative Data Processing
1967

too high due to confusion of terminology. Many of the applications reported as being on-line in 1967 were actually "in-line". A definite shift to the right (i.e. to batch and on-line computer usage) has occurred since 1967. Pressures being exerted at all levels for accountability have forced the administrators to generate every conceivable report or statistic which can be used for this purpose. As the chief administrators become more and more familiar with the computer and the systems become more responsive, this trend will continue.

Extent of Sharing Computers with Academic Users

In 1967, 12% of the computer installations were dedicated to administrative uses whereas this percentage dropped to 10% by 1970 (see Figures 5 and 6). On the other hand the percentage of installations being used for research, instruction and administration increased from 53% to 61% during the same period. I expect the corresponding percentage for 1977 to be in the 70-75% range.

Who Controls the Computer

During the period from 1967 to 1970 there was a definite shift toward the chief academic officer as the boss of the computer installation head and new titles appeared which were categorized as "Head of Computer Facilities". At the same time there was a decrease, percentagewise, in the number of installation heads reporting to the "Chief Business Officer". The 1970 pattern is expected to be close to what now exists.

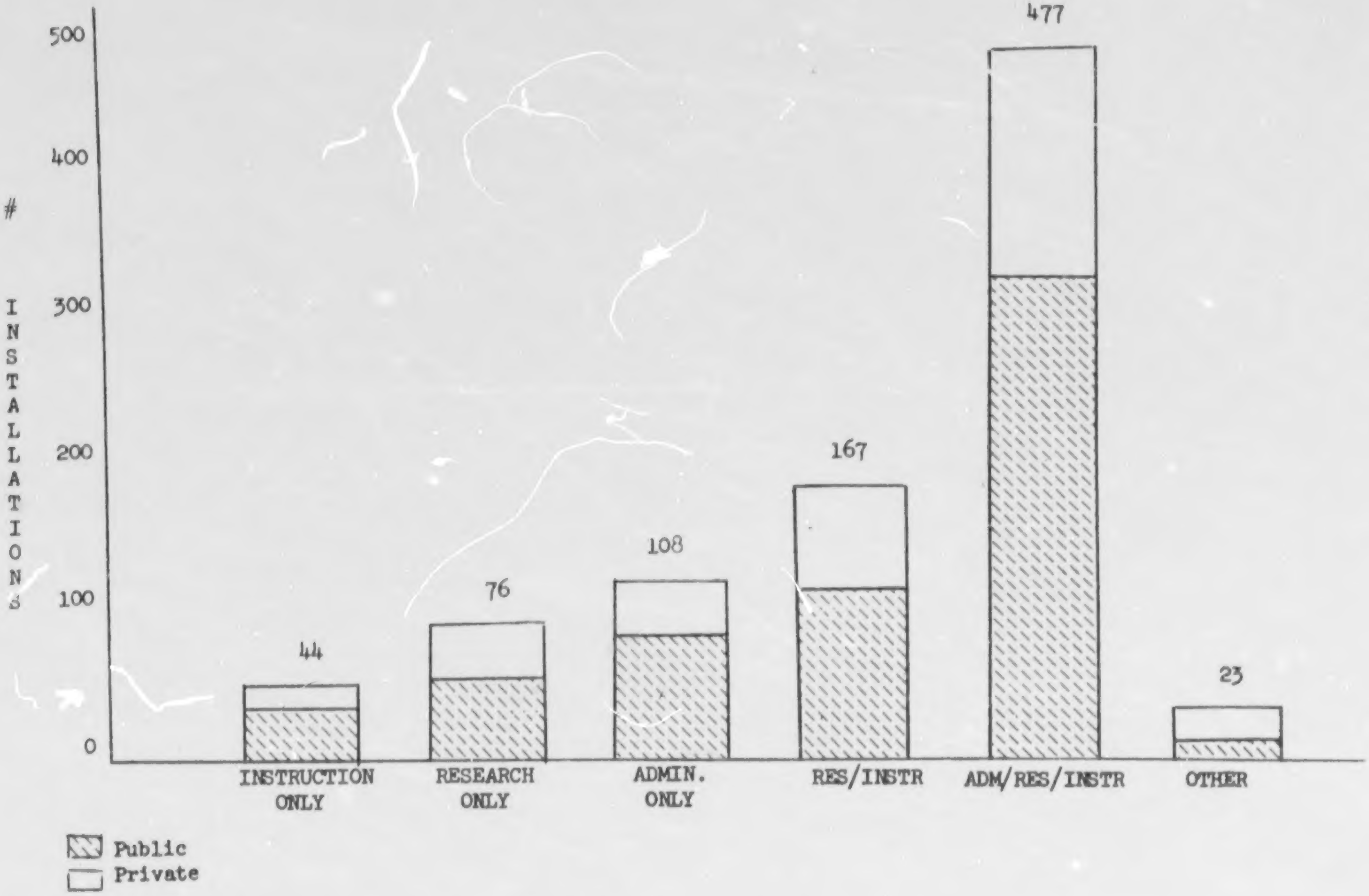


Figure 5

Computer Installations by Type and Usage
1967

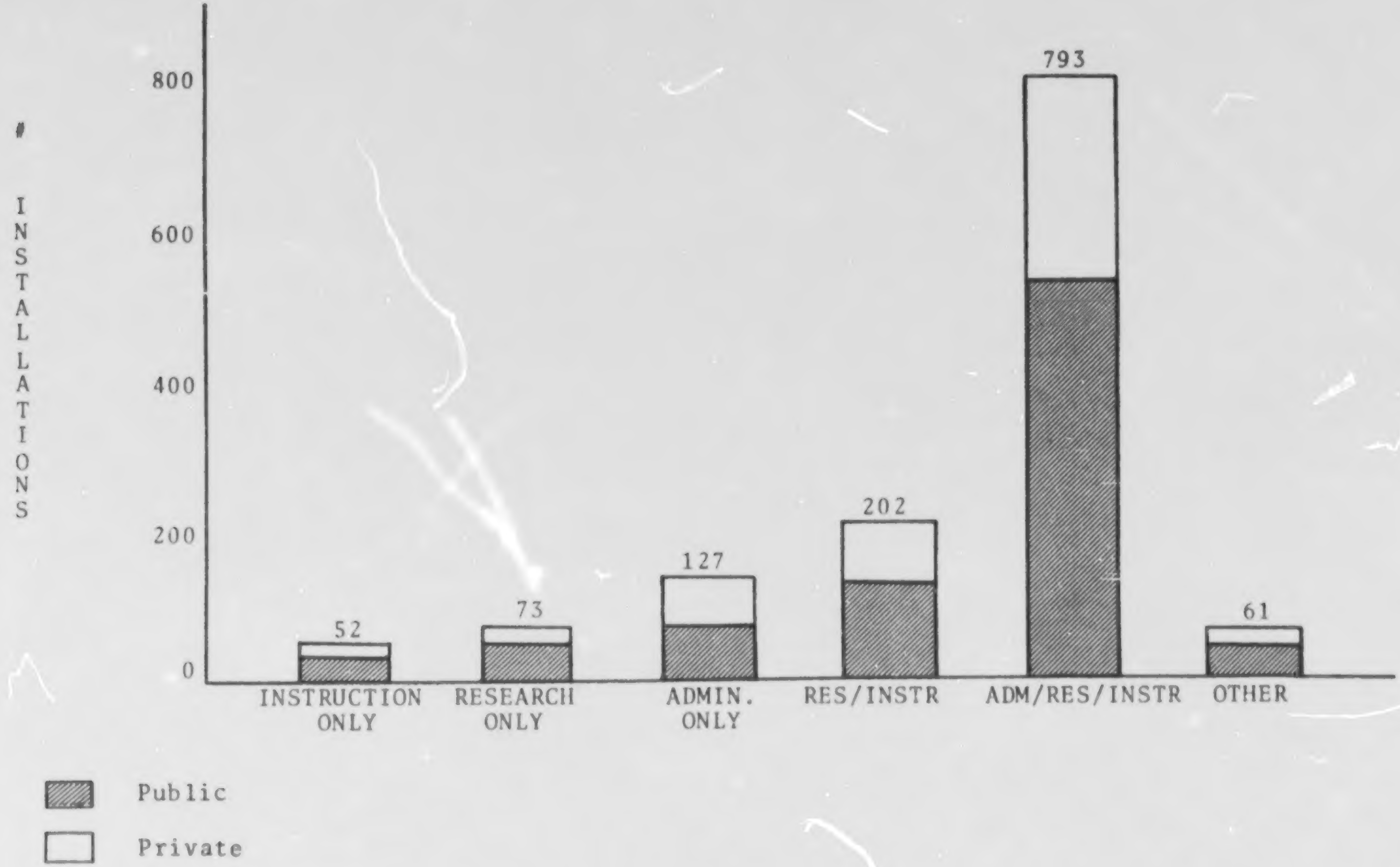


Figure 6
Computer Installations by Type and Usage
1970

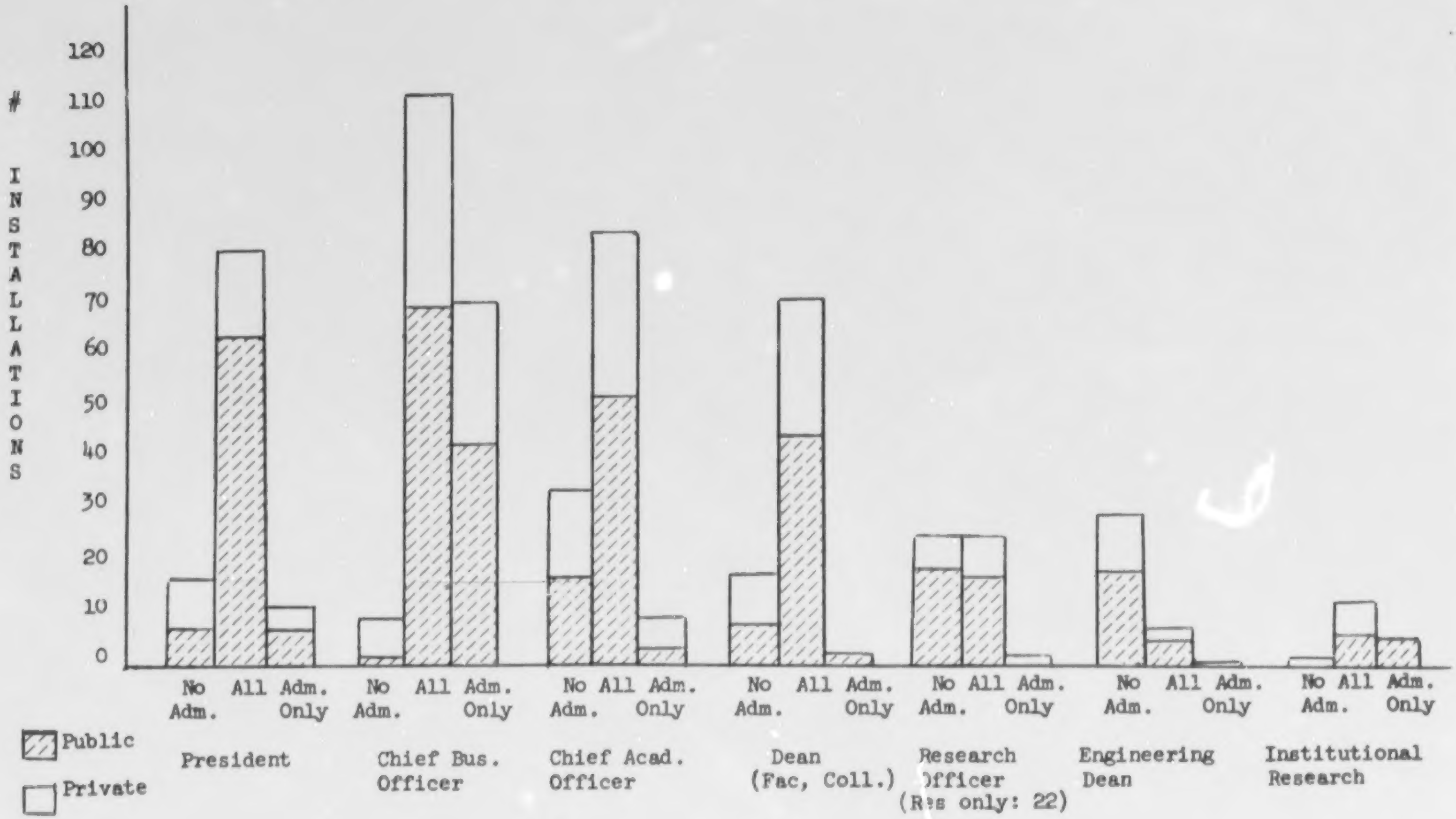


Figure 7

Title of Officer to Whom Head of Computer Installation Reports by Type of Usage of Center - 1967

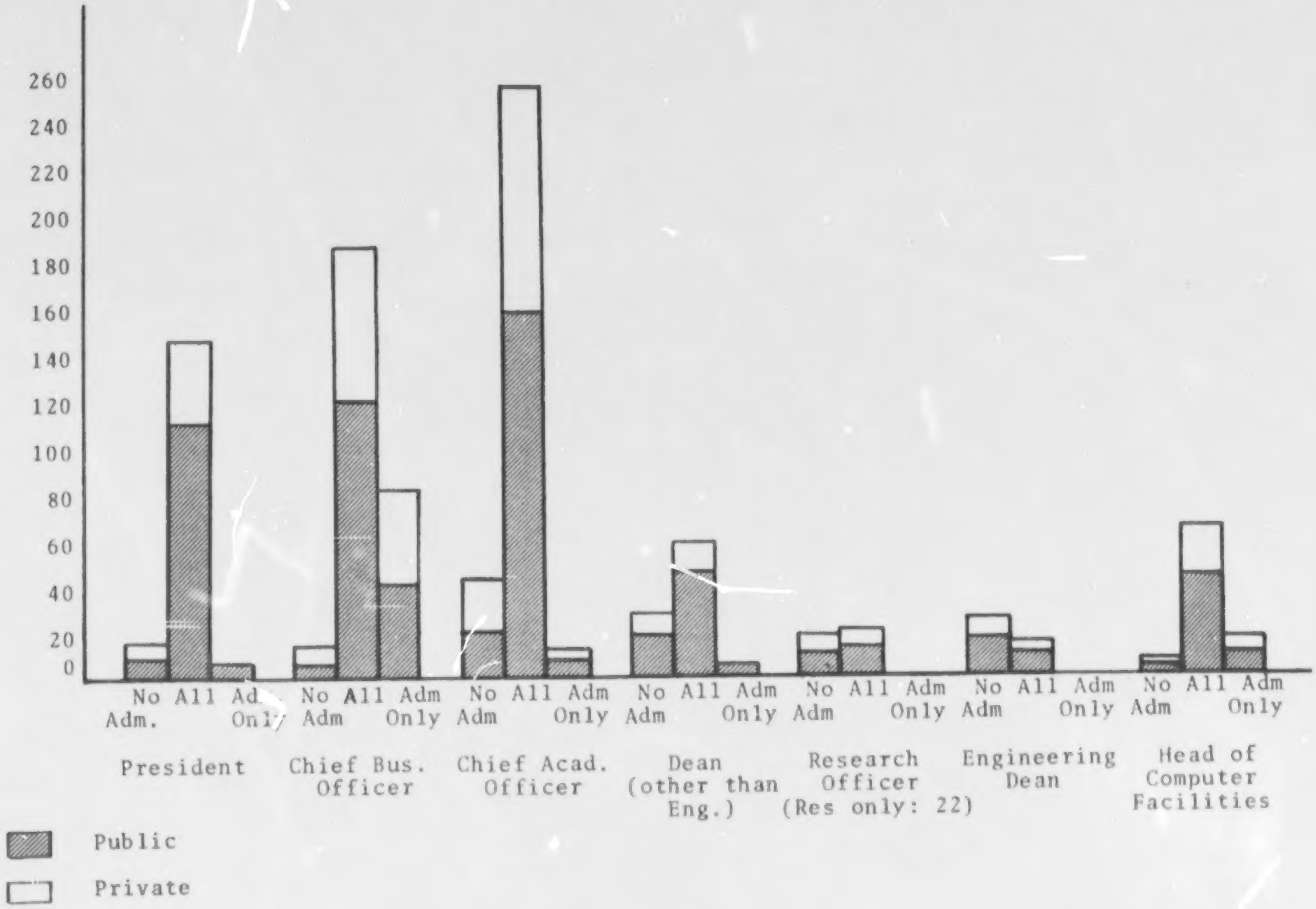


Figure 8

Title of Officer to Whom Head of Computer Installation Reports by Type of Usage of Center - 1970

Types of Computer Facilities

In numbers of computers the stand-alone batch system is by far the most numerous administrative computer. Very few time sharing only systems are used for administrative data processing. On the other hand, the combined time sharing and batch system has become more prevalent since 1967, and is now the rule in large universities rather than the exception. Star networks providing both remote batch and time sharing capabilities are now common at multi-campus universities and state systems. It is not likely that networks will be utilized across systems or state boundaries for administrative applications, in general.

Modes of Operation

At one-campus institutions, the computer installation staff usually has responsibility for systems analysis and design, programming and operations. For most installations, except for the largest institutions, this is the best mode of operation. Some large institutions have separate but central systems and programming staffs. These staffs tend to be large during the design, development and implementation stages and later are allowed to diminish for maintenance purposes. Ideally, some of the systems staff should be absorbed in the various administrative user departments as openings occur. If carried to extremes, this could develop into dispersed systems and programming staffs which have some inherent inefficiencies. If the systems staff is dispersed, then coordination of system changes becomes very difficult if done at all. The lack of such coordination can soon destroy an otherwise good system. Furthermore, some units would not be likely to have enough work for one systems analyst or maybe too much for one but not enough for two, etc. This situation is likely to cause staffing problems and does not allow efficient use of systems personnel. This latter objection is even more true for the programming function. The initial "bump" in staffing systems and programming can be avoided by purchasing software. Those who decide to take this route should check out the vendor very carefully and have a carefully worded contract with regard to testing before payment. There are attorneys who specialize in such contracts and one should be consulted before the contract is signed. Software purchase is compatible with either the central or dispersed systems and programming staffs.

Some have proposed a mode of operation which they term as "User Driven Systems". Such an approach mandates dispersed systems and programming staffs since the end users are not capable of driving the systems. The interface languages are entirely foreign to them and the preciseness required can be completely frustrating to them. Perhaps this will change someday, but for the present and near future users who are expected to drive their own systems, will be hiring analyst/programmer types to serve as their "chauffeurs".

Another mode being bandied at present is the "utility" concept. Basically it is the provision of computer power with no concern by the installation personnel as to what the uses are. A very enviable position for the installation personnel, but torment for the users unless they have excellent systems and programming personnel. If the computer can be truly operated as a utility then perhaps its maintenance and supervision should be relegated to the Physical Plant Superintendent. Computer installation heads who seriously propose that the computer be operated as a utility don't want to be bothered by user problems and use the utility concept as a "cop-out". Users who may be confronted with a utility prospect should check out other alternatives, such as a commercial supplier of computer power or their own small computer. Utility proponents are likely to become overly awed with new hardware and will make changes with little or no regard to the problems to be caused to the user.

The utility concept may someday be operable in a state or university system network if each campus or institution is responsible for the maintenance of its own data bases according to established standards with either central or dispersed systems, programming and operations staffs. Furthermore, reports should not be generated from the campus data bases without giving the appropriate campus personnel a chance to review the output and verify its accuracy.

What Does the Future Hold?

Rather than repeating by summarizing, I will use the space for some further predictions for the next ten year period.

1) University systems offices will continue to develop information systems in order to attain and maintain control even though the systems will be much more costly and take much longer to develop than proponents estimate.

2) Independent campuses will discover the "turnkey" system and distributed computing with mini systems not yet on the market. Firmware will be widely substituted for software in these systems. The business office will be the earliest customers because they have access to the resources and a harbored distrust of any staff other than their own with their data.

3) More computer sicence educated data base management systems personnel will be required in the administration offices to accomplish much with either of the above alternatives.

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PLANNING COMPUTING IN A TURBULENT ENVIRONMENT

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External demands for economy and accountability and internal pressure for zero growth management have prompted higher education administrators to move toward rational long-range planning processes for all facets of the institution. Ironically, the computer function, which is an essential resource to successful strategic planning in a complex institution, is not easily subjected to a rational planning process. This paper discusses the variety of forces in the computing function's environment which cause it to be turbulent and virtually uncontrollable. This paper also examines these forces and the impact they have on the planning process employed for computing.

PLANNING COMPUTING IN A TURBULENT ENVIRONMENT

INTRODUCTION AND CONTEXT

The principal business of universities and colleges has been and must continue to be the dispassionate concern for truth. While that may sound trite, it is the basic axiom for our existence. This concern for truth is easily overlooked in the hectic daily life of an institution. Those of us involved in planning, managing, and controlling the computing function in institutions of higher education must be super-conscious of this concern for truth, because computing could easily become the "tail that wags the dog" in the impending era of uncertainty facing all of higher education.

While the concern for truth has been at the nexus of institutional life since the founding of the first two universities at Bologna and Paris in the 13th Century, the past 30 years have brought an unprecedented burgeoning of knowledge about the physical universe and the nature of man. In this brief moment of history man has learned, for the first time, the nature of life, the structure of the cosmos, and the forces that shape our planet. The depth and sophistication of scientific understanding gained can probably only be appreciated by those who have lived through the era.[1]

For those of us involved in the management of higher education, the past three decades have encompassed a period of transition which has moved universities from placid environmental settings with humanistic mission thrusts to turbulent environmental settings with a mixture of humanistic, political, social and scientific concerns permeating the missions. During the latter part of the 1950's and throughout the 1960's universities were motivated to become deeply immersed as a societal problem solver. The stimulation was in the form of massive federal, state, and philanthropic dollars for research and public service. During that time higher education also enjoyed top billing among all societal needs.

As we head toward the 21st Century higher education is being impacted in a dichotomized fashion. The scientific knowledge and understanding we have acquired and continue to generate has resulted in whole new sets of industries whose products touch almost every aspect of our daily lives. One product - the digital computer - is among the most prominent to significantly affect institutions of higher education at their very foundation. Originally invented as a tool for scientific research, the computer is now an essential resource for an increasing range of academic disciplines in all three mission areas - research, instruction, and public service. There is the widespread belief that there is little hope of maintaining leadership in discovering new knowledge, competence in transmitting it, or success in applying it without the effective use of such a resource which characterizes institutional excellence. It has also become an imperative tool for administrators in the management of an institution.

The growing demand and potential for computing as a resource tool comes at a time when higher education has lost its top billing among societal needs and the impetus of external funding sources has substantially declined. Clark Kerr has suggested many times that we are entering a period of uncertainty, conflict, confusion, and potential change similar to that experienced by higher education from 1820 to 1870. That period was one which gave us the dual system of higher education, private and public institutions; the elective curriculum combining both the traditional liberal arts with pragmatic/vocational education; an expansion of the mission of institutions to include research and public service; and a whole range of new institutional types including state colleges, the agricultural institutions, teacher's colleges, and community colleges; and the adoption of universal higher educational opportunity.

As we face the last quarter of this century, is it not ironic that, in part, a product of our acquisition of new knowledge is the major instrument being used to constrain and make accountable the institutions that search for truth? The dichotomy of the situation is this - computing, as an institutional resource, is in its embryonic stage of development in most institutions, but it is operating within the mature, perhaps a bit fossilized, enterprise known as higher education.

Given this general context the basic question facing most of us present here today is "How do we plan computing for the long range given the environmental context in which institutions of higher education are operating?"

WHY PLAN? WHY CHANGE?

There seems to be increasing interest in planning in all sectors of higher education. Without a doubt the most compelling reason for institutional planning can be attributed to the crises which are affecting many institutions. Quantitatively, many institutions are suffering from levelling or declining enrollments and a shrinking financial resource capability. Qualitatively, some institutions are eroding or displacing their mission,objectives, and programs for the sake of "survival." An institution which bases its planning purely on the premise of "survival" is not apt to be successful in the long run. Institutional planning, to be constructive and to insure a healthy future for the institution, must be based on the premise of "self-renewal." It must objectively seek and create for itself future opportunities with the various publics it can serve. These ideas about institutional planning apply equally well to planning the computing function with the institution.

For an institution to be successful in its computing planning effort, it must be open to change. For change to be successful, it must incorporate high quality technical solutions to the institution's computing situation and the changes must be acceptable to the members of the institution. Change is inevitable in our dynamic society, and computers are at the forefront of influencing change. Change will happen to an institution whether or not it is anticipated in a plan. There is a risk in planning computing because it may lead to changes which significantly affect the institution's mission and thereby the behavior of its participants in unanticipated ways. However, the risk of not planning computing is far greater, for the changes that will occur will then be externally initiated. Through a process of planning computing those of us who are managers in the area have an opportunity to insure that future development and changes are based on the sound principles, premises, values, and philosophies which promote the business of the institution and not those of external forces.

THE NATURE OF PLANNING

Planning theorists have inundated the literature with a myriad of planning frameworks, schemes, systems, and processes. Each represents the perspective and discipline orientation of its author(s). The one thing that these frameworks appear to have in common is the notion that long range planning is a rational process, conducted by rational people to achieve maximum gains and benefits for the organization. I stand here to tell you that long range planning for any facet of any organization, including the computing function, is as much a political and emotional process as it is rational.

Even with that knowledge, I subscribe to the notion that long range planning for computing must begin with a framework - a single lens through which all those participating or affected by the planning can view and understand it.

Planning is a process which has been defined in several different ways by as many authors. Russell Ackoff defined it as well as any:

> "Planning is a process that involves making and evaluating each of a set of interrelated decisions before action is required, in a situation in which it is believed that unless action is taken a desired state is not likely to occur and that, if appropriate action is taken, the likelihood of favorable outcome can be increased."[2]

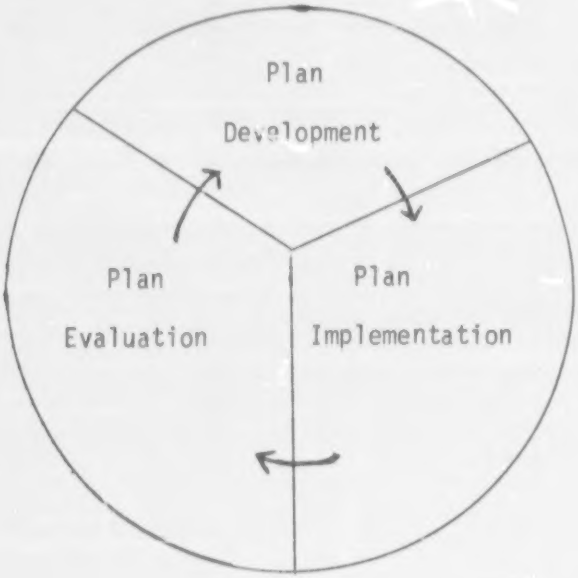
Lorange and Vancil define it very similarly:

> "A strategic planning system has two major functions: to develop an integrated, coordinated, and consistent long-term plan of action, and to facilitate adaptation of the corporation to environmental change."[3]

In a simplistic way I define planning as a process. Planning is the most important undertaking for any organization or system for it provides the operational base and guidelines from which all substantive decisions (policy and operational) should be developed and implemented. With the appropriate foundation, the many substantive decisions related to the functions and activities of an organization can be supplied as a means of achieving specific objectives.

As depicted in Figure 1, the planning process involves three phases: development, implementation, and evaluation.

Figure 1. The Planning Process



The plan development phase of the process involves:

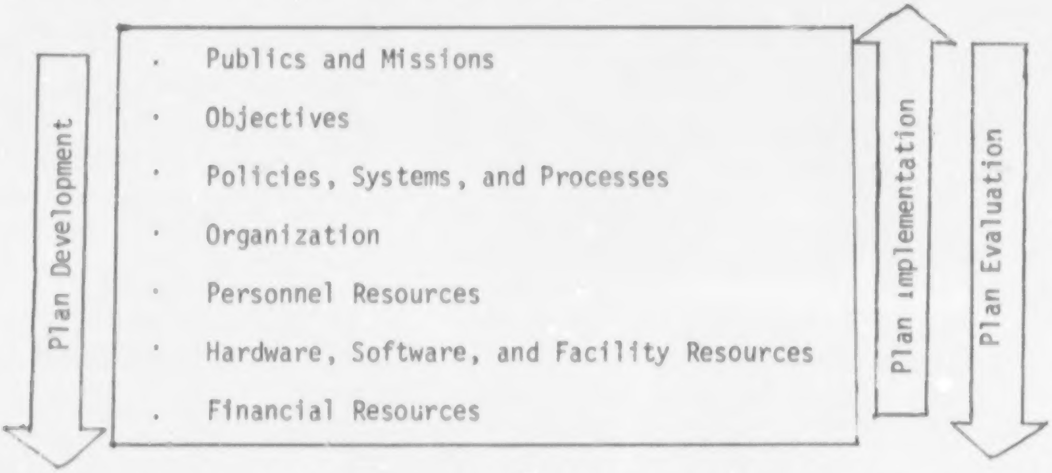
1. The adoption of a framework or agenda;
2. The identification of key problems, issues, and opportunities confronting the computing function;
3. Analysis of the dimensions of each issue in a concept paper;
4. The accumulation of accurate data about these problems and issues;
5. A statement of current status of each issue including interrelationships with other issues;
6. The exploration of future alternatives that might emerge out of present conditions;
7. The assessment of possible consequences of the various alternatives; and,
8. The recommendation of an alternative for implementation relative to each issue addressed.

The plan implementation phase involves carrying out developed plans within a prescribed time schedule and organizational design. Plan evaluation is a built-in method of determining the degree of attainment of the plan's objectives. Evaluation is conducted against a pre-determined set of criteria.

There are two levels of planning to be considered in the planning process - strategic planning and tactical planning. Strategic planning provides the foundation and direction within which tactical planning operates. Strategic planning is the periodic effort designed to specify and adjust the overall mission, objectives, and programs of the computing function for a set period of time into the future - usually five or more years. Tactical planning is an ongoing effort in which specific problems and issues of the highest priority are confronted individually so that their cumulative resolution leads to the fulfillment of the strategic plan.

The planning process is continuous; hence, no plan or document is final. A plan is an interim report always subject to alteration. As a continuous process, all three phases are going simultaneously in an ideal planning effort. First, however, an organization must launch an initial planning effort which concentrates on plan development. As a prerequisite to developing an initial strategic plan, the managers and administrators of the computing function must adopt a framework. In essence, this framework will become the agenda to be used in developing a plan. For a framework to be useful,the basic components and their concepts and variables must be concise,inclusive and must be presented in an interrelated way for realistic treatment. As shown in Figure 2, there are seven components identified as part of a strategic planning framework.

Figure 2. The Strategic Plan Framework


Plan Development
· Publics and Missions
· Objectives
· Policies, Systems, and Processes
· Organization
· Personnel Resources
· Hardware, Software, and Facility Resources
· Financial Resources
Plan implementation
Plan Evaluation

These components must be addressed within the context of the environmental setting of the institution and the computing function.

The Structure. As stated earlier, planning is a process which embraces two levels - strategic and tactical planning. Tactical planning is essentially best carried out within the existing decisionmaking process. Strategic planning, however, is best carried out by a special structure(s). This process requires the formation of a special task force comprised of managers and users of the computing function to handle this as a primary activity. The planning task force should be appointed by the chief administrator of the computing function or the president of the institution. The selection should be based on criteria established by user committees and computing function managers. The criteria for selection should include: analytical ability, objectivity, willingness to exert extra effort, and so forth.

Process and Time-Action-Plan. The objective for the planning task force is to develop an initial strategic plan for the computing function in a very short time - an inverse Parkinson's law - collapse the work to fill the time allotted. To accomplish such an objective it is necessary to prescribe a process and a time schedule. The following process is designed to secure maximum participation from all publics within the institution and to provide for feedback to those publics at appropriate times in the process. The major activities or events in developing a plan include:

1. Issue Identification - The problems and concerns facing the computing function must be identified and prioritized for use by the planning task force. These issues form the basis for developing a plan within the suggested framework.
2. Concept Paper - Once an issue (or a group of issues) has been identified, the planning task force must write a concise document defining the concepts, terms, and dimensions of the issue. Also, policy alternatives should be stated, but no commitment to a proposed solution should be made.
3. Status Paper - Related to the issue or issues for which a concept paper has been written there should be a statement of the current status of the computing function relative to that issue. Supporting data should be included.

4. Open Hearings - The planning task force should hold open hearings for each issue or provide for some feedback from various publics. At the same time, individuals and groups can make their feelings known.
5. Invited Position Papers - In addition to open hearings, individuals or groups should have the opportunity to submit papers stating a position on an issue or issues.
6. Choice of Alternative - After securing the input from the various publics, the planning task force should make a choice among the alternative solutions for each issue.
7. Planning Document - The alternatives for each issue should be integrated into the planning framework and presented in the initial planning document.
8. Plan Adoption - The planning document should be submitted by the planning task force to the appropriate decisionmaking units. This may include user policy committees, the top administrator of the computing function, and the executive administrative body of the institution.

After an initial plan is adopted, the process then moves to implementation. At the same time plan development within other issue areas might be initiated. Rather than attempting to encompass all the identified issues, this procedure suggests the need to limit the issues considered by the planning task force.

To this point, the planning framework described is based totally on a rational approach. No allowance has been made for the human, political, and emotional elements which always intrude on the clarity and precision of rationality in planning.

Russell Ackoff has described three approaches to planning, two of which are vital to the above framework - satisficing and adaptivizing.

In satisficing planning, an attempt is made to minimize the number and magnitude of departures from current policies and practices. Only modest increases in resource requirements are recommended and there are not any large changes in organizational structure. The satisficing planner tends to enter the future facing the past and is preoccupied with one resource, money. Satisficing planning seldom produces a radical departure from the past and usually yields conservative plans which continue most current policies, correcting only obvious deficiences.[4]

Adaptive planning is based on the principal value that planning does not lie in the documents produced but in the process of producing a plan. Planning arises out of the lack of effective management and controls. The objective is to design an organization and a system for managing that will minimize the future need for retrospective planning. Based on the knowledge that the future carries certainty, uncertainty, and ignorance, adaptive planning involves the dimensions of commitment, contingency, and responsiveness. Adaptive planning recognizes that some aspects of the future are virtually certain, in which case the primary need is for a commitment to a continuous updating of the estimates of what is inevitable or is unchanging and required. There are certain aspects about the future of which we cannot be certain, but we can be reasonably sure of the possibilities. In these cases we use contingency planning to prepare for each eventuality so that we can quickly exploit the opportunities that are presented when the future presents iteself. Finally, there are aspects about the future which we cannot anticipate, including technological breakthroughs and political and natural phenomena. In these cases responsiveness planning needs to be incorporated. Responsiveness planning is directed toward designing an organization and a system for managing which can quickly detect deviations from the expected and respond effectively to them.

The adaptive planner tries to change the system in a way that will make more efficient behavior follow naturally. Adaptive planning requires an understanding of the dynamics of values - the way values relate to needs and their satisfaction and how changes in needs produce changes in values and what produces changes in needs.[5]

One more dimension to a long range planning strategy must not be overlooked. In the final analysis, planning should be value based, not data based. The complexity of the organization will determine the degree of differences in the values among the suborganizations and groups. These differences may lead to conflict. Therefore, the planning strategy should seek to reduce conflict by approaching the process utilizing several small cell groups or task forces of people who focus on a piece of the planning process. Do not have one task force or group undertake the entire effort.

As the top computing planner and administrator the natural question becomes,how then do you present a comprehensive, cohesive, and integrated long range plan to the president of an institution? The answer, you don't. What you seek to achieve is the inculcation of the planning process which will enable you and other managers in the institution to deal effectively with the uncontrollable factors in your planning environment.

This combination planning strategy is best illustrated by a description of the process as employed by the Indiana University Computing Network. I offer it because it is my only experience in planning the computing function for an institution.

THE INDIANA UNIVERSITY COMPUTING NETWORK:
AN OVERVIEW

The Network Components

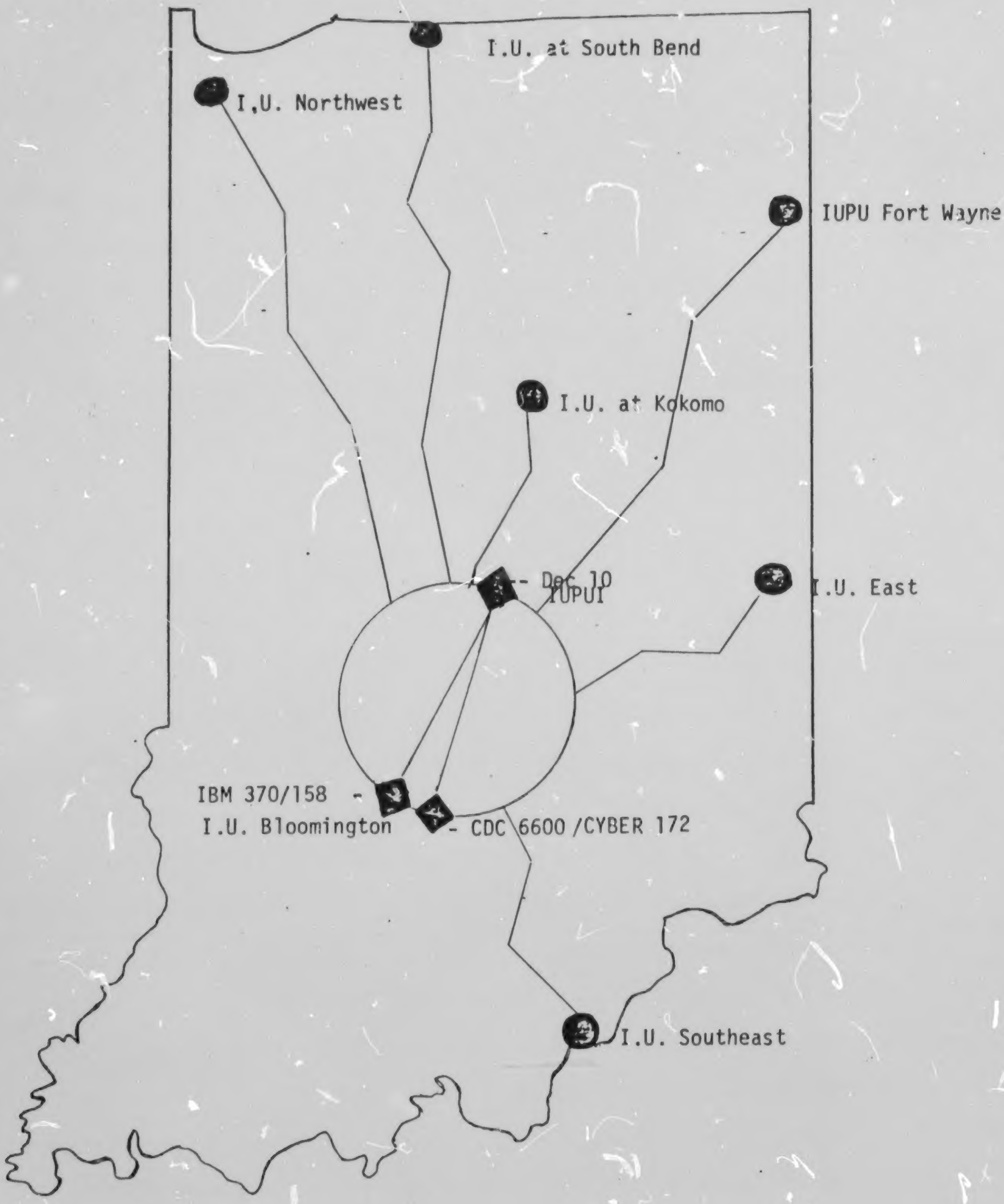
Since 1971 the Indiana University Computing Network has come into being, grown, and evolved into a valuable resource with which to support and enhance the major computing tasks related to research, instruction, public service and administration in the Indiana University system. Currently, each of the eight campuses is linked to three central computing facilities by a data communications network. Basically, each campus has the same computing capability available to its faculty, students, and administrators. Figure 2 shows the location and linkages of the campuses. The three central computing centers are Data Systems and Services (D. S. & S.), the Wrubel Computing Center (WCC), and the Indianapolis Computing Center (ICC),serving 76,000 students and 5,000 faculty and staff.

Data Systems and Services, located on the Bloomington campus, is the administrative data processing department for the Indiana University system. This department is charged with the responsiblity for designing systems, writing programs, and processing data for all administrative offices throughout the institution. The equipment is an IBM 370/158 computer. Each campus has remote batch job entry and on-line terminal access via the data communication network.

Research, instruction, and public service users are provided access on a restricted basis where educational and economic requirements justify the use of the IBM 370/158.

The Marshall H. Wrubel Computing Center is a Universitywide academic computing facility located on the Bloomington campus. It is designed to facilitate academic research, to participate in the instructional program, and to contribute to the development of computer sciences as a subject of study throughout Indiana University. Wrubel is the primary academic batch facility for the University. However, it does also provide 48 ports of interactive service. While the equipment, a Control Data Corporation 6600 and CYBER 172, accommodates everyone from the student learning to program to the advanced research specialists,its strength is doing large numerical analysis vital to research.

Figure 3. Indiana University Computing Network


I.U. at South Bend
I.U. Northwest
IUPU Fort Wayne
I.U. at Kokomo
Dec 10
IUPUI
I.U. East
IBM 370/158
I.U. Bloomington
CDC 6600 /CYBER 172
I.U. Southeast

Indianapolis Computing Services is the newest computing organization within Indiana University. It has a Digital Equipment Company DEC 10 computer located on our Indianapolis campus. Indianapolis is primarily organized to facilitate interactive academic computing and has 96 ports which can be accessed from any campus via the data communication network.

The Data Communications Network provides the primary means for each campus in the University to access the three central computing centers for service. The communication network connects the campuses to each of the three central computers through multiplexing equipment located at the Wrubel Computing Center. Currently, communications are handled by telephone lines, but plans are now under way for a microwave network.

THE CURRENT MANAGEMENT STRUCTURE

In 1971 President Ryan realized the growing role computing would play in the life of Indiana University and appointed a part-time special assistant to be responsible for all computing throughout Indiana University. In 1973 the Office of Information and Computer Services was established with a full-time director to assume the responsibility for planning and coordinating academic and administrative computing for the Indiana University system. This office is currently part of the portfolio of the Vice President for Administration.

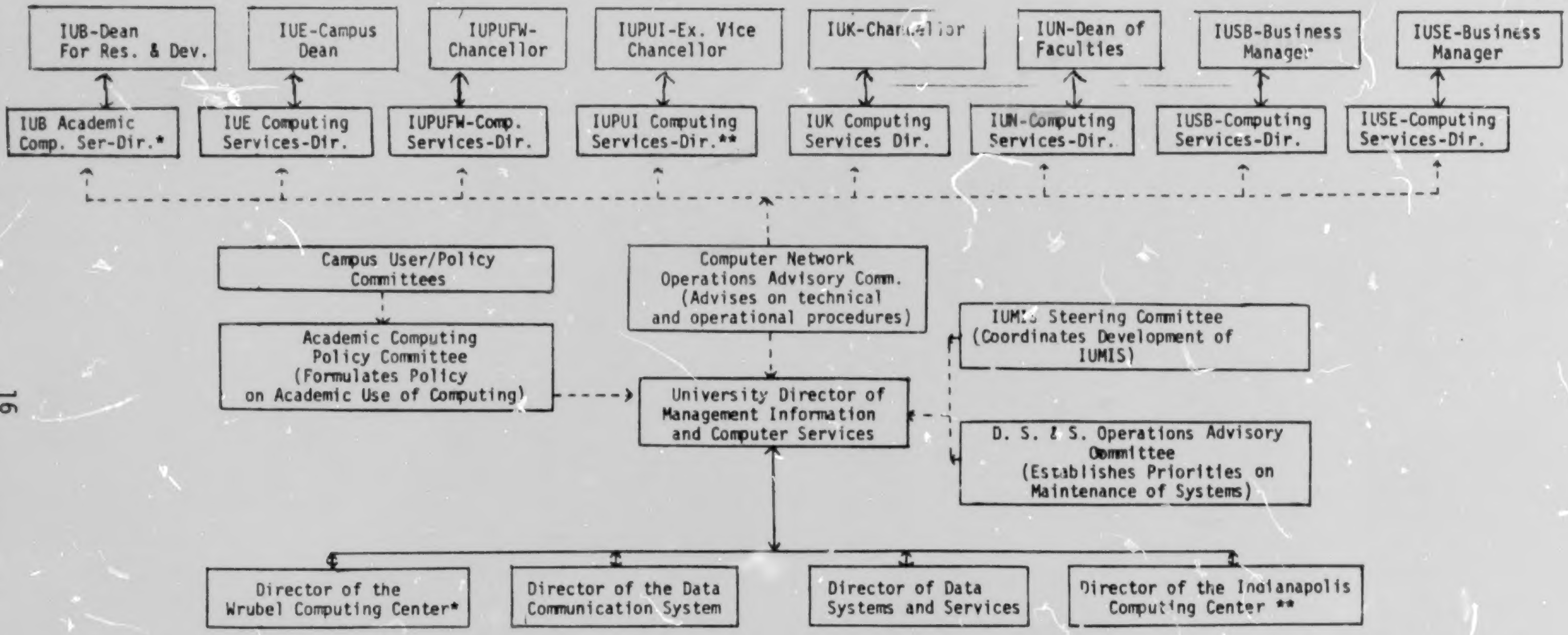
In addition to planning and coordinating centralized administrative and academic computing services, except Hospital Data Processing, the Office of Information and Computer Services is the control point in the University administration for the development of any other computing resource acquired for the University. The computing services available through IUCN are designed to satisfy most general computing needs. Any new computer services or hardware, whether for a single campus or multi-campus purpose,are planned and approved in conjunction with the Office of Information and Computer Services in order to avoid unnecessary duplication of facilities, costs, and services. It is also through this office that the planning and development of the Indiana University Management Information System (IUMIS) is being directed.

The management relationships within the Indiana University Computing Network form a very complex set of interrelationships. Figure 4 illustrates the current management relationships. Each regional campus computing center director is directly accountable to a key administrator on his or her campus. Each also has a functional relationship to the Network management through involvement in the work of the Computer Network Operations Advisory Committee.

The director of Indianapolis Computing Services is responsible to the University Director for network services in academic computing. At the same time he is responsible to the campus management for local academic and administrative computing. The director of the Wrubel Computing Center also has a split responsibility but is accountable for academic computing only to the Bloomington campus management.

Although the director of Data Systems and Services reports only to the University Director, he also is the only link for administrative computing users in the Bloomington administration. The director of Communications Systems Development has only a Network responsiblity.

To complement the management structure of the IUCN, four faculty/staff committees have been established. The Data Systems and Services Operations Advisory Committee establishes priorities on use and maintenance of administrative computer systems. The IUMIS Steering Committee coordinates the development of IUMIS. The Computer Network Operations Advisory Committee advises on technical and operational procedures of IUCN. The Academic Computing Policy Committee formulates policy on the research and instructional use of computing. This committee is advised of user needs by various campus committees.


IUB-Dean For Res. & Dev.
IUE-Campus Dean
IUPUFW-Chancellor
IUPUI-Ex. Vice Chancellor
IUK-Chancellor
IUN-Dean of Faculties
IUSB-Business Manager
IUSE-Business Manager
IUB Academic Comp. Ser-Dir.*
IUE Computing Services-Dir.
IUPUFW-Comp. Services-Dir.
IUPUI Computing Services-Dir.**
IUK Computing Services Dir.
IUN-Computing Services-Dir.
IUSB-Computing Services-Dir.
IUSE-Computing Services-Dir.
Campus User/Policy Committees
Academic Computing Policy Committee (Formulates Policy on Academic Use of Computing)
Computer Network Operations Advisory Comm. (Advises on technical and operational procedures)
IUMIS Steering Committee (Coordinates Development of IUMIS)
University Director of Management Information and Computer Services
D. S. & S. Operations Advisory Committee (Establishes Priorities on Maintenance of Systems)
Director of the Wrubel Computing Center*
Director of the Data Communication System
Director of Data Systems and Services
Director of the Indianapolis Computing Center **

* The same person is the director of WCC and the director of Bloomington Campus Academic Computing Services

** The same person is the director of Indianapolis Computing Center and director of IUPUI Computing Services

——— Direct Authority Relationship

- - - - Policy and Advisory Relationships

Figure 4. INDIANA UNIVERSITY COMPUTING NETWORK: MANAGEMENT STRUCTURE

The planning framework and process described earlier has been in use in the Indiana Network since my arrival in 1973. Prior to that time each central computing center operated independently of the other two centers and each did its own planning.

While the management structure of each center is still separate, we have completed some significant planning in a number of areas including: an overall long range hardware plan; the Indiana University Management Information System project; and, a financing strategy for academic computing. In addition, there are a number of other areas where planning is currently underway: Computer-Assisted-Instruction (PLATO); the role of the mini and micro processor in the network; and communications microwaving. There are still other areas we have hardly touched. Specifically the overall organizational design and management of the Network is a pending issue.

ENVIRONMENTAL ASSESSMENT

As stated, planning takes place within an environmental context. A critical facet of any planning effort is making an ongoing assessment of the environmental status of the organization. The Indiana University Computing Network environment rates as highly turbulent and virtually uncontrollable. Several factors contribute to this rating - users, technology, management behavior, institutional inertia, and resource allocation and control strategy.

Users. Although Indiana has had nearly a quarter-century of computing experience, our current assessment indicates we have only begun to scratch the surface of its potential as an academic subject of a study; a research, instructional, and public service tool; and as an agent of change in the management behavior of the institution itself. Approximately 15% of the faculty and a slightly larger percentage of students currently make extensive use of computing. At the current growth rate, however, we expect to have 40%

to 50% of the faculty and an even larger percentage of students using computing within the decade. Our assessment also indicates that there is a shifting in the type of computing users from those who have been technically grounded with programming skills to those who will be unsophisticated and need package programs and consultant support. Also, we have projected that the "soft" sciences will overtake the "hard" sciences in hardware utilization within the decade.

We are uncertain as to the impact that Computer-Assisted-Instruction may have on Indiana University. Small experimental work has been going on using the programming languages which exist on the current hardware. In addition, the Bloomington and Fort Wayne campuses have pilot use of PLATO. We currently have a planning effort going on in that area. The primary hindrance for a burgeoning of Computer-Assisted-Instruction using the PLATO system has been the faculty reward system. Faculty are not rewarded for developing Computer-Assisted-Instruction programs.

Administratively, we find that most operations currently use data processing as an integral part of their activities. However, we do have in the embryonic stage the automation of the University Library and text management use by the Publications Office. We feel there are a number of other potential users that have not yet surfaced.

While the extent of the University's commitment to use its computing resources in the public service mission has not been defined in a policy, the gathering and dissemination of information is consistent with the purpose of the institution. Currently, we have a limited number of public service activities with external agencies through various schools and administrative units of the University. One public service area in which we are currently doing some planning is a career vocational information system.

We are exploring the possible use of a package called DISCOVER for a massive distribution to the secondary schools throughout the university and possibly the secondary school system.

Technology. You are all cognizant of the technological changes which have affected the computing function. The three areas that will probably have the most significant impact in the future are mass storage (the bubble technology), microprocessing, and communications (microwave and satellite). At Indiana the mini and microprocessing impact on the Network is very uncertain and somewhat out of control. In spite of the fact that my office must approve all computer equipment, this whole area has a way of sneaking through the cracks. The number of minicomputers at the departmental level is growing at an incredible rate. One of our problems is that we have two different purchasing agents for large and small equipment acquisitions. Of course, who really can tell whether a piece of equipment is classified as computer related or not in this day and age? Software development in areas such as text management promises to impact computing resources at institutions. Suffice it to say that those involved in planning computing must provide sufficient flexibility to accommodate the new technological changes with minimal disruption to the organization.

Management Behavior. Administrators and staff at a university can be described in a trinary fashion - zeroes, ones, and others. The zeroes are those who do not trust the computer at all. They would rather have people with green eye shades and tennis shoes generating numbers with paper and pencils. The ones are zealots who wish to put everything on the computer, regardless of need for computerization. The others category present the real problem area. On one hand they are zealots wanting to use the latest technology; on the other hand, they also want tennis shoe people to verify the accuracy of the computer. Maybe you do not have this problem, but we do at Indiana.

Institutional Inertia. Planners must be able to perceive the inertia in a situation and be able to penetrate it at vulnerable points to effect change. It is natural for an organization to continue to flow in the direction that it has been headed and thus to resist changes. Our major inertia problem at Indiana University is that we say we are a multi-campus system, yet each campus and the major administrative units in the two largest campuses, Bloomington and Indianapolis, tend to move in their own autonomous directions.

Network computing is one of the few systemwide services which appears to have the support of all of the campuses and to have a positive direction as a system. Yes, there are pockets of independent actions in the use of computing. Data processing at the University Hospital is one example of a counterforce within Indiana University computing which has historical and political overtones.

Computer Resource Allocation and Control. We are all confronted with the problem of allocation and control of scarce computing resources. A variety of strategies has been employed. At Indiana the individual faculty, student, or staff member has always had "free access" to the computing resources. In fact, there is not any individual or any departmental accountability made for the use of Network resources. The lowest level allocation charges assessed is at the campus level. If any one here has some proven techniques for forecasting, allocating, and controlling the use of the computing resources, Indiana University would be delighted to hear about them.

We do try to prioritize and allocate analyst and programmer resources to new and existing administrative applications. However, without any chargeback system we have been unable to get administrative departments to regulate their own use of computing in difficult times. Academic computing users do ration their use on a first come first serve basis. Incidentally, we are going to do something about control in the second semester, and I am going to be a task force of one.

This is a brief description of environmental factors affecting the planning efforts in the Indiana University Computing Network. Should we view our environment as turbulent and challenging?

ANALYSIS OF A HARDWARE PLANNING EFFORT

One of the most visible efforts of planning computing at Indiana University was performed during 1975-76. Our effort focused on developing a long range computing hardware and communications strategy. The following is a description of the structure, process, and outcome of that effort.

Task Force Structure. In June,1975, I appointed a hardware task force consisting of three faculty members and the directors of the three computing centers and data communications. The faculty members were given summer stipends to work on this planning effort - a strategy I recommend to secure their commitment. The task force was given the task of recommending a 10-year hardware strategy for the Indiana University Computing Network. This recommendation was to be submitted to me by April 1, 1976. The recommendation ultimately came in July 1976.

Development Phase Process. The task force was not formally introduced to, or asked to endorse, the planning framework as shown in Figure 2. Rather, the task force took as given the existing mission and publics, the overall objectives, and the current policy, systems, and processes of the Network. In essence, the task force dealt with only one variable in the framework - hardware.

The task force did divide its work into three stages and established completion dates for each stage.

		Original Due Date	Actual
1.	Data Collection and Alternative Strategies	January 1, 1976	January 1, 1976
2.	User and Administrator Reaction and Comment	March 1, 1976	April 15, 1976
3.	Alternative Recommendations and Endorsement	April 1, 1976	July 1, 1976

The task force followed fairly closely the rational process of events and activities described earlier (pages 8-9). However, one *satisficing* factor became a major guideline to the task force. The pattern for hardware funding was to be constrained to a 5% per year increase over the 1975-76 base for a seven year period. This growth would be consistent with the forecasted funding growth of the overall institution.

Stage 1. The task force identified and dealt with a number of issues reflected in three major questions.

What is the current status and projected growth in the administrative, instructional, research, and public service functions of the university?

Data on the current and historical status of computing were readily available from each of the central computing centers. These data were analyzed by mission area, campus, and academic unit. In addition, the task force conducted a needs analysis, using the questionnaire and interview techniques. Over 3500 questionnaires were sent to potential respondents throughout the University; 405 completed questionnaires were returned. A variety of statistical analyses were made to identify the current level of utilization and problem areas as they related to geographic location, position, and experience of the user. The faculty members on the task force interviewed major users on all eight campuses. Special interviews were also conducted with the leaders and planners involved in library automation, the PLATO project, and the Indiana University Management Information System project.

From the analysis of interviews and questionnaires computer use projections were developed. The projections provided the basis for determining the quantity of hardware that should be incorporated in the various alternatives. Another result of this effort was the identification of areas of concern. The task force attempted to determine whether or not these concerns were part of strategic or tactical planning. In the case of tactical planning concerns, they were passed on to the managers of the Network.

What new services or applications might be implemented in the University in the future? How would such services affect the Network hardware and what would be the cost? Dealing with this question,the task force identified four new service areas which might have a major impact on the plans for Network hardware. The largest potential service identified was that of Computer-Assisted-Instruction using the PLATO system. For a number of years there had been a small experiment using PLATO terminals connected to the University of Illinois. More recently the University Computer-Assisted-Instruction Committee had endorsed PLATO as the high level language to be used for Computer-Assisted-Instruction throughout the institution.

A second service area identified was the automation of the library system. The task force found an embryonic development,but the plan did not have the endorsement of the top administration within the institution.

The third area identified was the growing need to have linkages with national external data bases in academic disciplines. The final service area was the issue of extending the institution's capability to external agencies as part of the public service mission of academic units. Although this activity was going on in a modest form, the University was without a policy statement.

What changes in direction of computing might affect the existing or projected hardware resources of the Network? How might they be dealt with effectively? For the Indiana Network the most significant change in computing direction was the growing use of interactive terminals for academic computing and the development of several online administrative systems. Interactive academic computing was a political issue among the user committees. The old-timers argued that interactive computing was an inefficient use of the hardware and, therefore, should not be significantly expanded. Newer users and those ardent proponents of interactive computing argued that personal effectiveness was increased by having access to the computer via terminals. Without a doubt this issue was both political and emotional throughout the planning process.

The recent emergence of minicomputers throughout the institution raised the issue of whether or not to interface them to the Network hardware, and if so, how. The task force recognized the need for policy development in this area but decided that the issue could not be addressed effectively within the scope of the present planning effort. However, the task force did recommend that a technical work group be formed to determine an alternative course of action.

Likewise, several other issues which could technically alter the Network were identified, but scoped out of the current planning effort. Examples include online mass storage, graphics, and distributive processing.

The task force also addressed the issues of academic and administrative computing consolidation and the consolidation of the two academic computing centers. More will be said later about dealing with these issues.

While the task force members kept the user committees on all of the campuses informed throughout the first stage, individual concept, status, or alternative papers were not distributed during Stage 1. Rather, three documents were prepared to present the total work of Stage 1. Two documents: Indiana University Computing Needs Analysis: Questionnaire and Interview Results and Current Central

Systems Computing Hardware and Software Resources provided valuable detailed resource information to the user community. The third document entitled: Long Range Computing Hardware and Communications Strategy: Issues and Alternatives was the key product of Stage 1. In essence, it presented each issue, defined the terms, gave current status, made projections, and offered the alternatives for each issue that was considered within the scope of this effort.

At the heart of the Issues and Alternatives document was the presentation of three alternatives for hardware development covering a 14-year period. The alternatives rejected any possibility of merging all of academic and administrative computing into one large hardware system. The task force concluded that academic users within Indiana University demanded an open system approach, while administrative computing needs demanded a more closed system approach. Furthermore, the complexity of Indiana University seemed to justify such separation.

The task force also concluded that the University already had too much invested with the current three vendors to consider moving toward an entirely new set of vendors. The only consideration, with divided opinion, was to offer a hardware alternative which eliminated the DEC 10 system as a Network resource and to move all of its interactive academic computing to the CDC system.

The other two alternatives maintained the DEC system as a Network resource. In one almost all interactive computing would be dedicated to a multiprocessing DEC 10 system with 256 ports. There would be limited access through 48 ports to the CDC system for batch augmentation use. In the other alternative the DEC system would be topped out at 128 ports and interactive computing would grow to 176 ports on the CDC system.

In all three alternatives administrative data processing was to be done on a multi-processing IBM 370/158. All alternatives also recommended that a

256 port system be provided for the PLATO project on the CDC system. However, no provision was made for library automation, because it appeared to lack any official endorsement within the institution.

All three alternatives carried a total price tag ranging from $25.7 million to $28 million dollars for the 14-year period, excluding communications cost. The lowest alternative was the one eliminating the DEC system and the highest was the one using the DEC system for almost all interactive academic computing.

Stage 2. As part of the second stage of development of the planning process, these documents were circulated widely throughout the University. User committees on all campuses and administrators were asked to respond in writing by March 1. This was later extended to April 15. Instead of conducting open hearings, the task force members met individually with campus user committees to discuss and receive comments. To say the least, it was a volatile period within the institution. The one alternative suggesting the elimination of the DEC system was both political and emotional on the Indianapolis campus and among selected users at the other campuses.

Each campus committee did make an official response to the task force. Responses combined rational, political, and emotional feedback. As might be expected, there was very little feedback from the administrators.

Stage 3. The strategy finally recommended by the task force expressed the adaptivizing nature of planning. It was based on the rationality of feedback, plus the political and emotional factors. Two major questions were raised by the user community. There was a concern for the length of the planning period given that changing patterns, growth in computing needs and technology could modify substantially future hardware requirements. The second concern was for a continuing program to more effectively evaluate computing use and needs.

The task force took these actions in its final recommendations to me adapting them from the feedback received.

1. Specific hardware recommendations were made for a three year period, 1976-77 through 1978-79. This hardware recommendation preserved for later option the choice between growing interactive computing on the DEC system or the CDC system. The alternative of disposing of the DEC system was discarded as politically not feasible nor educationally desirable.
2. The Computer-Assisted-Instruction (PLATO) was to be limited to a 32-port system for thorough evaluation during this same period. Feedback revealed there was no overwhelming support among the users for PLATO. Further, some political realities concerning earlier attempts on the part of the institution to get state funding for PLATO were revealed which caused the task force to remove it from a full-blown recommendation.
3. Groups were to be established to facilitate planning for library automation, external data base interfaces, and minicomputer interfaces to the Network.
4. An evaluation system was to be established to begin the working of updating the hardware plan in 1978-79.

Already, since July, there have been alterations to the three-year hardware configuration. These alterations have been based on later information and emerging needs. Because we have a plan, an interim report, we are able to adapt to these new changes and still operate within the financial constraints that we have to satisfy.

SUMMARY

This has been an attempt to share one institution's planning experience utilizing a planning framework and process which accommodates rational, political, and emotional behavior to be present in the planning environment. In essence, planning of computing is suggested to be as much value-based as it is data-based. A rational framework and process must serve as a foundation; however, successful planning must be adaptive to its environment and satisficing to its participants. Finally, while comprehensive planning is ideal, reality dictates that several task forces be assigned specific facets of the overall effort to be accomplished over time. Planning, strategic or tactical, is an ongoing responsibility that we as planners, managers, and controllers of the computing function must view as being at the nexus of our work.

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INFORMATION SYSTEMS FOR UNIVERSITY PLANNING

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This paper proposes construction of a separate data base environment for university planning information, distinct from data bases and systems supporting operational functioning and management. The data base would receive some of its input from the MIS/transactional data bases and systems through a process of "clipping" to develop temporal uniformity and a process of "filtering" to reduce the volume of information and to prepare it for a useful role in the planning environment. Also proposed is an added concentration in both the MIS/transactional and the planning system environments (but particularly in the latter) on non-quantified data. The paper also suggests the need for new software tools to accommodate establishment of data bases containing both quantitative and non-quantitative information. Major issues concerning archiving of data, the role of "meta-data," or information about the data, processes, and institutional policies are also discussed.

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Also proposed is added concentration in both the MIS/transactional and the planning system environments (but particularly in the latter) on non-quantified data, and suggests the need for new software tools to accommodate establishment of data bases containing both quantitative and non-quantitative information. Major issues concerning archiving of data, and the role of 'meta-data', or information about the data, processes, and institutional policies are discussed.

This paper contends that significant differences exist between the kinds of information systems environments necessary to conduct ordinary university business and those needed to provide a workable environment in which academic planning can be conducted. These two kinds of information systems may be thought of as "management" and "planning" systems. The paper describes system characteristics, identifies their relationship to each other, and delineates some of the data elements of interest in each.

In order to better understand the differences, to see how they serve a university, and to determine how they relate and how they function, we must examine some basic concepts and define some terms.

One of those terms is "transactional system". The transactional systems of the institution are those which support its operational functioning. These systems ideally are supported by unified structures of data called data bases - structures which are intended to identify major groupings of data, to isolate access keys to the data, to reduce or eliminate redundance of data, and to unify the whole conceptually.

It is most convenient to think of a transactional system as maintaining a specific transaction-related data base. This is an over-simplification since the data bases of various transactional systems are generally linked together, but it makes the process conceptually simpler and is, therefore justifiable for the moment.

Given a set of transactional data bases and transaction systems which maintain them and make use of them, the systems normally thought to make up a "management information system" are, for purposes of this article, defined to be those systems which provide information permitting management to control the transactional or operational functioning environment of the institution. See Figure 1.

It has been found that a management information system generally requires information not provided by the collection of transaction systems. This we call "external data", and it is data - some of which is organized into data bases - which is used to augment the computerized system to make the information system complete. We refer here to information such as targets, schedules, standards and the like.

One can visualize the composite of the transaction data bases and those external data bases which are machine processed as a two-dimensional matrix involving the data elements and the data bases, with a third dimension provided by back-up and historical files of the data bases. Thus, Figure 1 shows the information set for transactional systems and management information as a cube, and while it is not perfectly correct, the analogy will suffice for our immediate purposes.

Two types of processes operate on the data structure so far identified - processes associated with the transactional systems and the management information system. The transactional system processes are relatively straight-forward. They acquire information from the external world, manipulate it and store it, and produce various outputs - outputs oriented toward the operational functioning of the institution.

The management information system processes are somewhat more abstract. Their composite structure consists of routine reports which are extracted from the data structure but also of specialized or "free form" extractions used to respond to questions of specific nature and short life. Thus, the computer programs and systems involved in the management information system change continuously, with old procedures and reports being discarded and new ones added, all resting on a base of relatively routine reporting.

In much the same way, an array of data can be visualized for the planning environment. A key difference exists, however. The planning information system requires a "three dimensional" set of information - data elements, data bases and historical representations of that information - whereas the management information system and transactional systems are generally based on current or near-current information and are much less involved with historical data. Figure 2 shows this.

It would be a mistake for systems planners to presume that the data elements and data bases required to properly support the planning function are simply those of the transaction and management information systems environment. It would also be erroneous to presume that the history information needed is the historical backup of the management information system. The planning data matrix is different than its counterpart supporting management information.

But where does the planning data come from? It is not, as one might expect, simply a direct transposition of the information used in the management information system, although a mapping does exist. (See Figure 3)

Figure 4 shows that a filter must be defined - a device which consolidates certain elements of data from the management and transaction information base, passes certain information through, and eliminates other information. The trick is to define the filter. This will be discussed later.

Once the filter has been determined, a process must be developed to create and maintain the historical file. This is done by a process we refer to as "clipping". One may think of the clipping activity as a process of cutting the constant stream of management information at appropriate times and passing that information through the filter. Note that the "clipper" must operate with specified and carefully determined frequencies, so that the historical files are created with uniform recurrence over some period. This is so because modeling must be possible over periods of time often spanning several cycles, and units of time must, therefore, be manageable - i.e. uniform. Figure 5 is a representation of the total system.

The process of defining the filter is all-important. Its function is to consolidate, transmit, or reject data elements which exist in the MIS data structure, and project appropriate information forward to the planning data base. This is a very critical function, for the utility of the planning data base is predicted by the design of the filter, and changes to the planning data base organization should be made only rarely - probably with great effort.

But clearly it is necessary to perform the filtering function, for with a complete MIS data base it would be impractical, expensive and non-utilitarian to maintain historical copies and attempt to use them as the bases for planning information - some compacting must occur. (For example there is no value in the planning environment in knowing that the name of an individual student changed during his or her academic experience at the university, but this is important information in the transactional system. The number of such changes in a time slice, however, might be useful planning information.)

The next step is not, as one might naturally conclude, to define the filter. First we must better understand what the data requirements of the two environments are. Let us take this in order.

First, we should define the data elements needed in the MIS environment. This non-trivial operation has been described in other publications for those elements which are part of the transactional data bases, and neither the process nor the elements themselves will be repeated here. Suffice it to say that they group themselves logically as: student, program, facilities, personnel, finance and alumni data bases.

But what about those data items which are required to develop a reasonably complete MIS environment but which are not derived from the transactional processes? They can be characterized, and fortunately they are mostly quantifiable. The author's (incomplete) list thus far includes:

*Targets, or quantified goals

*Schedules

-reporting

-operational

*Demand (market analysis)

*Strengths & Weaknesses

*Demographic Information

-about the community

-its institutions

-its people

*Standards

-performance

-tenure

-continuing employment

*Standard Models

-economic

-enrollment

-population

-compensation/collective bargaining

-resource consumption

*'Attitude' Information

These non-transactional information items are used in a variety of ways by the university manager, mostly to determine if operational parameters are 'in bounds', but also to perform relatively short-range planning or forecasting.

What must be discussed now are those data elements needed to support long-range planning functions. The author makes no claim that what follows is either particularly definitive or complete -- it is a first approximation, with much refinement required. Indeed, a careful study of the information requirements of chief executives and academic planners is essential before any such system should actually be constructed. The following is preliminary to such a study, and perhaps would serve as a base.

Planning data has several characteristics which separate it from transactional management data: the data is, where it evolves from MIS data, generally calculated -- the result of some operation being performed on the source data; some of it will be less specific than the MIS data; much of the useful planning data is not quantifiable and is available and used in rather unstructured forms, often as background information.

The list of information derived from the MIS data structure is likely to be extensive, and complete development of the filter will be a long and arduous task. But some comments as to the nature of the filter can be made, though tentatively. We will first consider the role of the filter as a screen through which the transaction/MIS data base is passed.

Here the filter does what its name implies -- it screens out unneeded transactional data to keep the planning base reasonable in size and well organized. It also must join elements of the various bases and establish needed links. If all transactional data bases were well-ordered and complete, the construction of the filter would be a relatively easy task, but in the light of reality, the filter will be a very complex set of programs indeed. However, no new software tools are needed, and concrete action can be taken rather immediately.

The other role of the filter is to manipulate and coalesce non-quantified information or information which is a product of operations performed on transactional data, perhaps having its roots in the MIS reporting processes. Before looking at the filter in this light, however, we must examine, more fully, certain aspects of the planning data base.

University administrators have known for some time what recently was verified by work at Harvard[1], that university top management, a group to which long-range planners belong, does not make substantial use of transactional data. Management tends to deal with quite different kinds of information, which is again termed as 'external' because it is acquired from outside the system.

The author's list of external information is not the result of thorough study of the needs of chief executives and planners. Rather, it was set down as a working model to permit conceptualization of the necessary technology and to clarify issues as to information classes and necessary structure. Therefore, it is with the proviso that it not be taken too literally that the author presents such a list. It thus far contains:

. Mission of the Institution and its Components
. Master Plans/Existing Plans
. Relations with Other Institutions

  - Inter-institutional Needs
  - Peer Group
- Demographic Information
  - Community Character
  - Reaction to the University
  - Services Rendered to Community
  - Potential Services
  - Cultural Needs
  - Types of Industry
- Community Leaders
  - Regents/Trustees
  - Key Alumni
  - Professional Societies
  - Educators
  - Business and Industry
  - Labor
  - Civic and Cultural
  - Federal, State and Local (Government)
  - Media
- Program (and Institutional)
  - Quality/Weaknesses
  - Relevance (Centrality)
  - Library Holdings
  - Resources and Facilities
  - Cost/Revenue Relationship
- Standard Models

- Progress Toward Targets
- The Decision-making Process
  - Formal Structure
  - Informal Structure
  - Timing

Two added 'external' information sets must be carefully considered. The first is the set of definitions of data elements. These become extremely important archival records, and are subject to change - yet the definitions applicable at a moment in time, applying to the archived data, are critical to proper understanding of the data.

The second information set deals with 'process', or the mechanisms by which data is generated and manipulated. While this is very complex and the author has not yet fully explored all ramifications, it appears that certain modules of computer code (procedures) represent university policy of the moment and themselves thus become candidates for archiving. This clearly opens a host of interesting technical questions.

The scope of information suggested for possible inclusion is great indeed - ranging from quantified or codified information through less traditional information which lacks structure and may not be quantifiable or even codifiable yet may beg for organization, indexing, etc. - on through information about information, and finally to information describing how other information is processed. This scope is well beyond the present state of the art. Yet in the long run, to produce an information system which will have broad significance to planners and chief executives - i.e. be able to cope with and accommodate the information needs - such must be considered.

Some work has been done to handle unstructured or non-quantified data, though none is known which has as its objectives those of this paper; an interesting system which is tangentially related is described in the CUMREC '75 proceedings -- "Executive On-Line Information System"[2].

Clearly, the computer can be used to process and organize unstructured and non-numeric information, but the primary question is, can it be made to relate to current concepts of data bases and processes for handling them? The author contends that it should, that much will be gained. But it appears that existing software systems developed to handle transactional information or data bases will have to be married to software which parallels software represented today by text handlers and editors, extended to permit more complex organizations. The existing tools do not appear to be adequate for the job, and a new bag of tricks and tools appears to be necessary.

But, while this paper has discussed the technology of planning information systems, the author wishes to stress again that a prior question must be clearly answered. It is, "What are the real information processing needs of chief executives and planners?". Attempts to develop systems without first having carefully developed the answer can lead to another of what a colleague calls "system juggernauts". It is my belief that the concepts presented here will prove useful in defining the technical issues and developing the support systems, but we must not lose sight of the fundamental mission.

---

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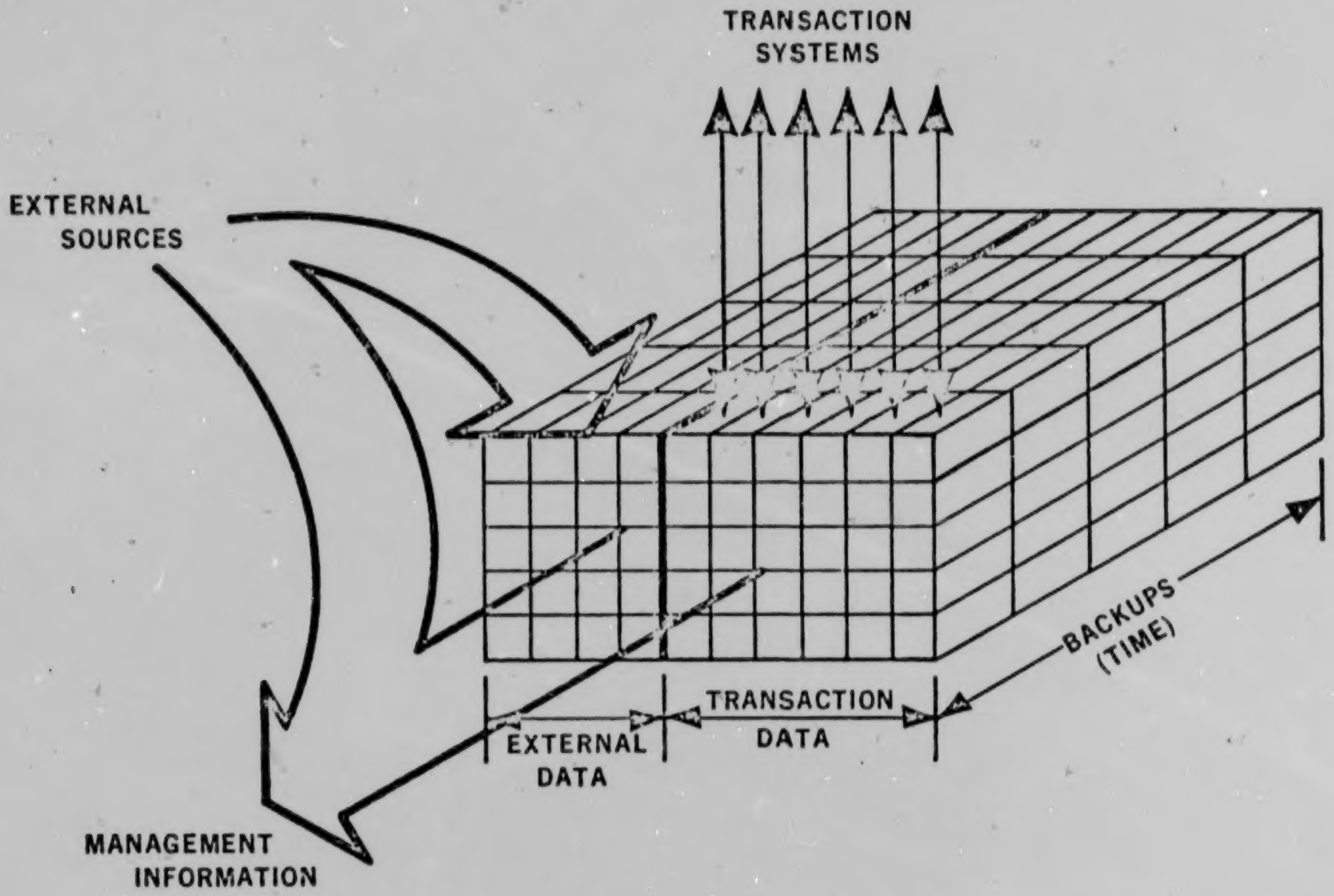

TRANSACTION SYSTEMS
EXTERNAL SOURCES
BACKUPS (TIME)
EXTERNAL DATA
TRANSACTION DATA
MANAGEMENT INFORMATION

FIGURE 1

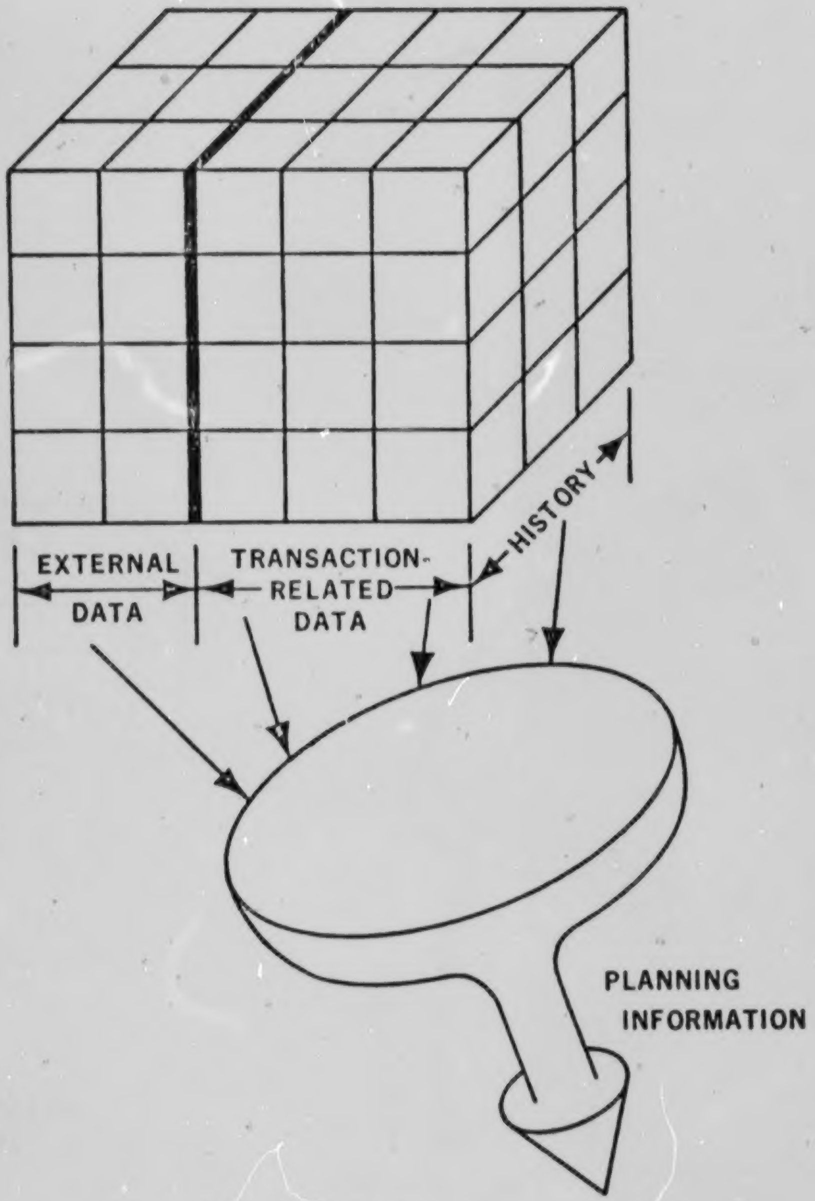

EXTERNAL DATA
TRANSACTION-RELATED DATA
HISTORY
PLANNING INFORMATION

FIGURE 2

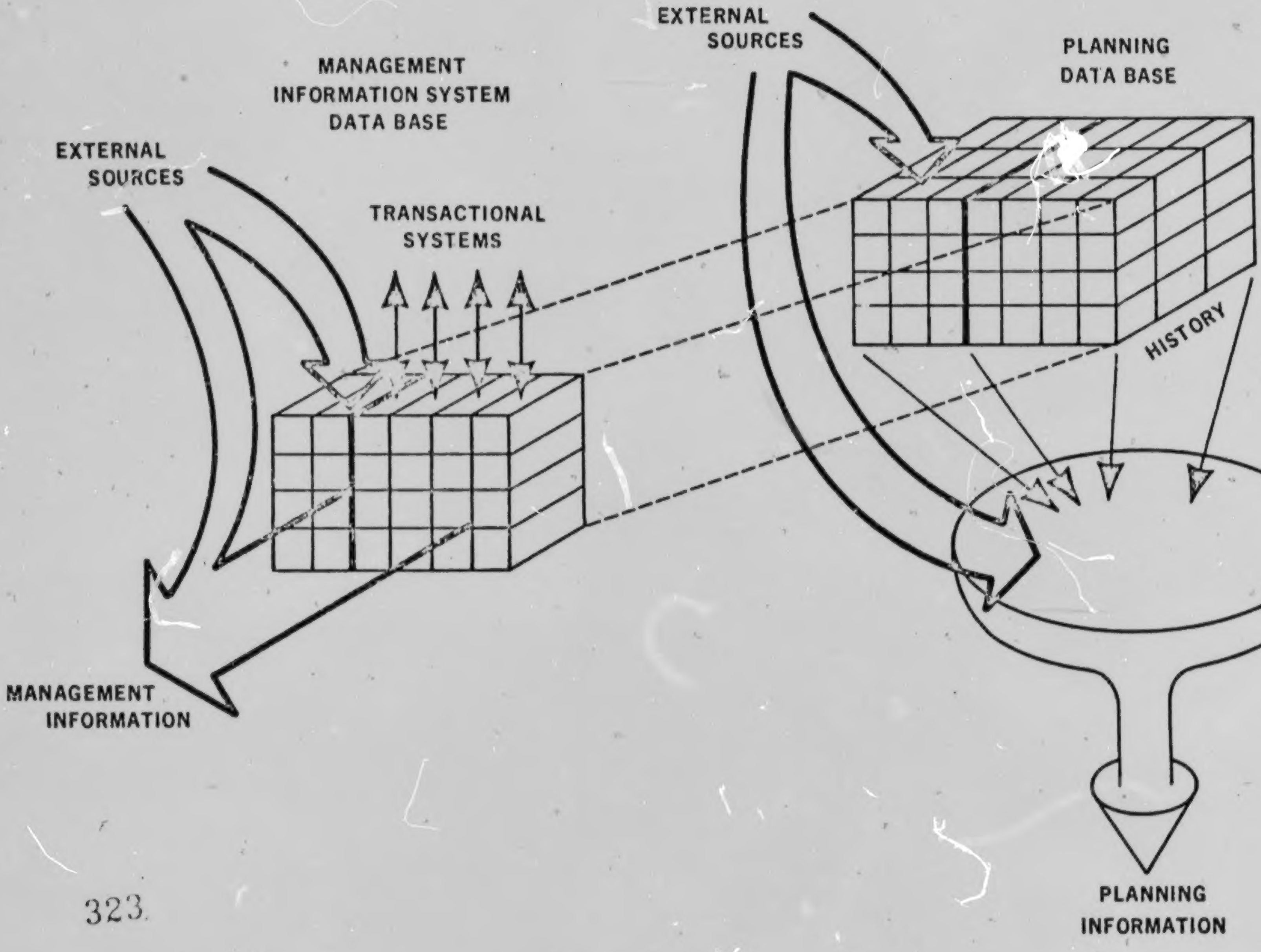

EXTERNAL SOURCES
MANAGEMENT INFORMATION SYSTEM DATA BASE
EXTERNAL SOURCES
TRANSACTIONAL SYSTEMS
PLANNING DATA BASE
HISTORY
MANAGEMENT INFORMATION
PLANNING INFORMATION

FIGURE 3

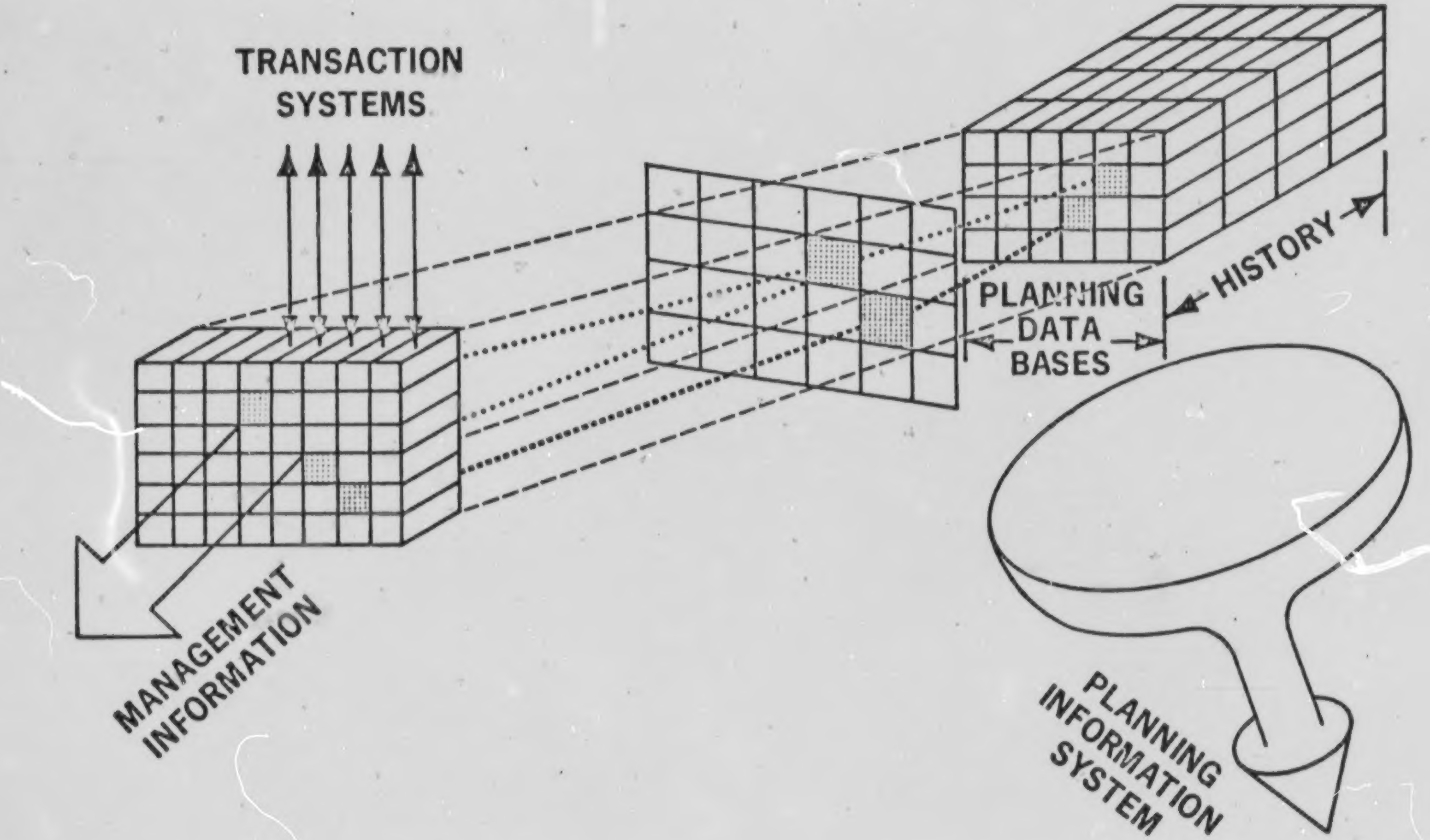

TRANSACTION SYSTEMS
PLANNING DATA BASES
HISTORY
MANAGEMENT INFORMATION
PLANNING INFORMATION SYSTEM

FIGURE 4

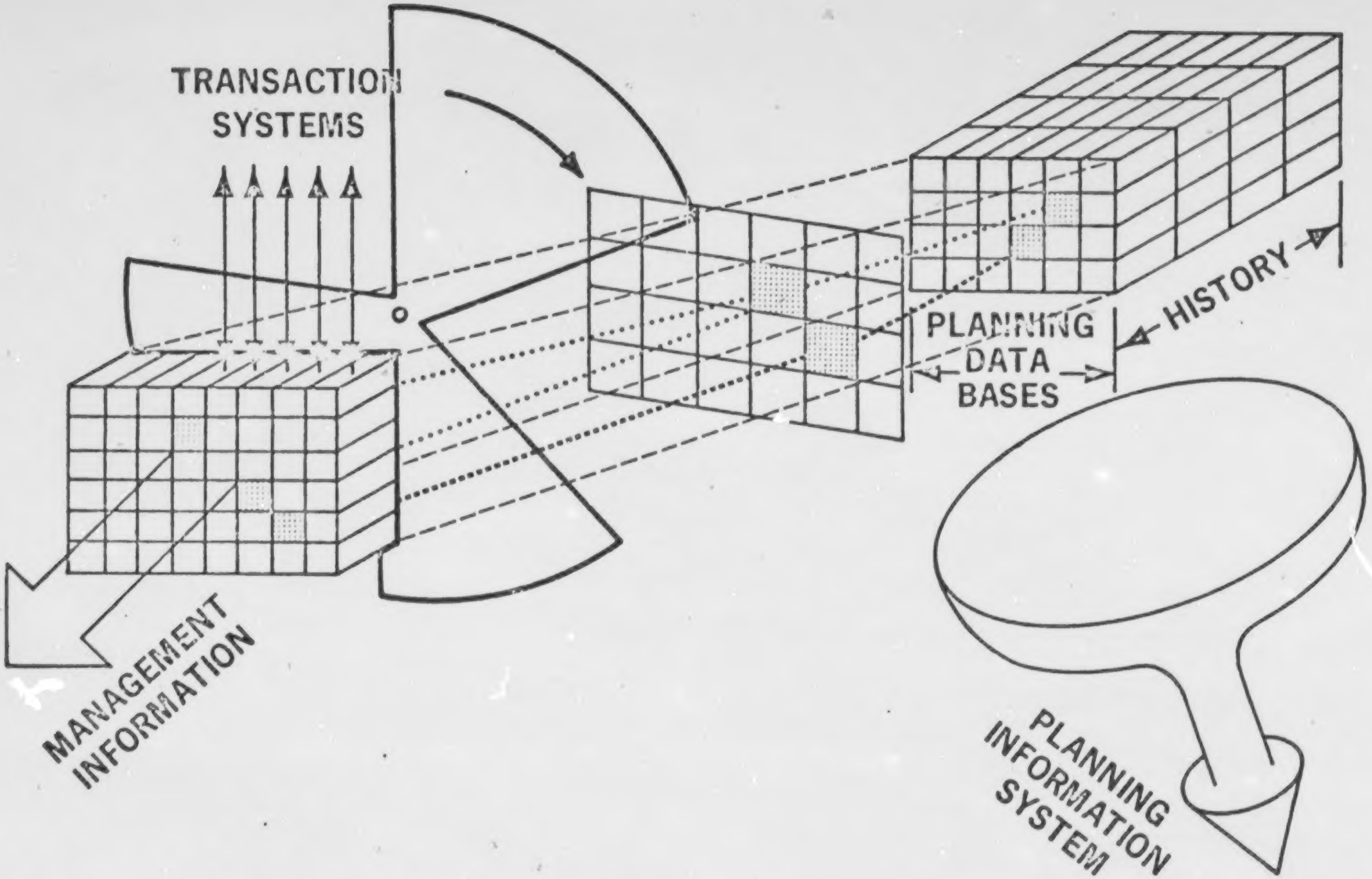

TRANSACTION SYSTEMS
PLANNING DATA BASES
HISTORY
MANAGEMENT INFORMATION
PLANNING INFORMATION SYSTEM

FIGURE 5

MANAGING A LARGE SHARED PROGRAMMING STAFF

John W. (Jack) Rust
Director, Computer Systems Division
SouthWestern Ohio Regional Computer Center (SWORCC)
University of Cincinnati
Cincinnati, Ohio

Managing a large systems and programming staff providing services to all areas of a major university, including administrative, academic, and medical, plus meeting the needs of other major non-profit organizations, including federal agencies, is a significant undertaking. This paper presents the management techniques utilized in directing the efforts of over eighty programmers and analysts as a case study of a unique approach to successful sharing of resources.

I. SUMMARY

Managing a large systems and programming staff providing services to all areas of a major university, including administrative, academic, and medical, plus meeting the needs of other major non-profit organizations, including federal agencies, is a significant undertaking. The Computer Systems Division of the SouthWestern Ohio Regional Computer Center (SWORCC) supports the University of Cincinnati, Cincinnati General Hospital, the Environmental Protection Agency, the National Institute of Occupational Safety and Health, the United States Postal Service, and a variety of other federal and local agencies. The management techniques utilized in directing the efforts of over 90 programmers and analysts provide an interesting case study in a unique approach to successful sharing of resources.

II. INTRODUCTION

A. Background of SWORCC

The SouthWestern Ohio Regional Computer Center (SWORCC) was formed in 1972 by the University of Cincinnati (U.C.) and Miami University (M.U.) to provide increased computer services to both campuses without a corresponding increase in budget allocation. This was accomplished by combining the computer centers into one central facility and by attracting other non-profit organizations to utilize the computer center. These objectives have been accomplished, and today, the two universities receive 6-10 times the computer services they received in 1972 for a fractional increase (less than inflationary) in costs.

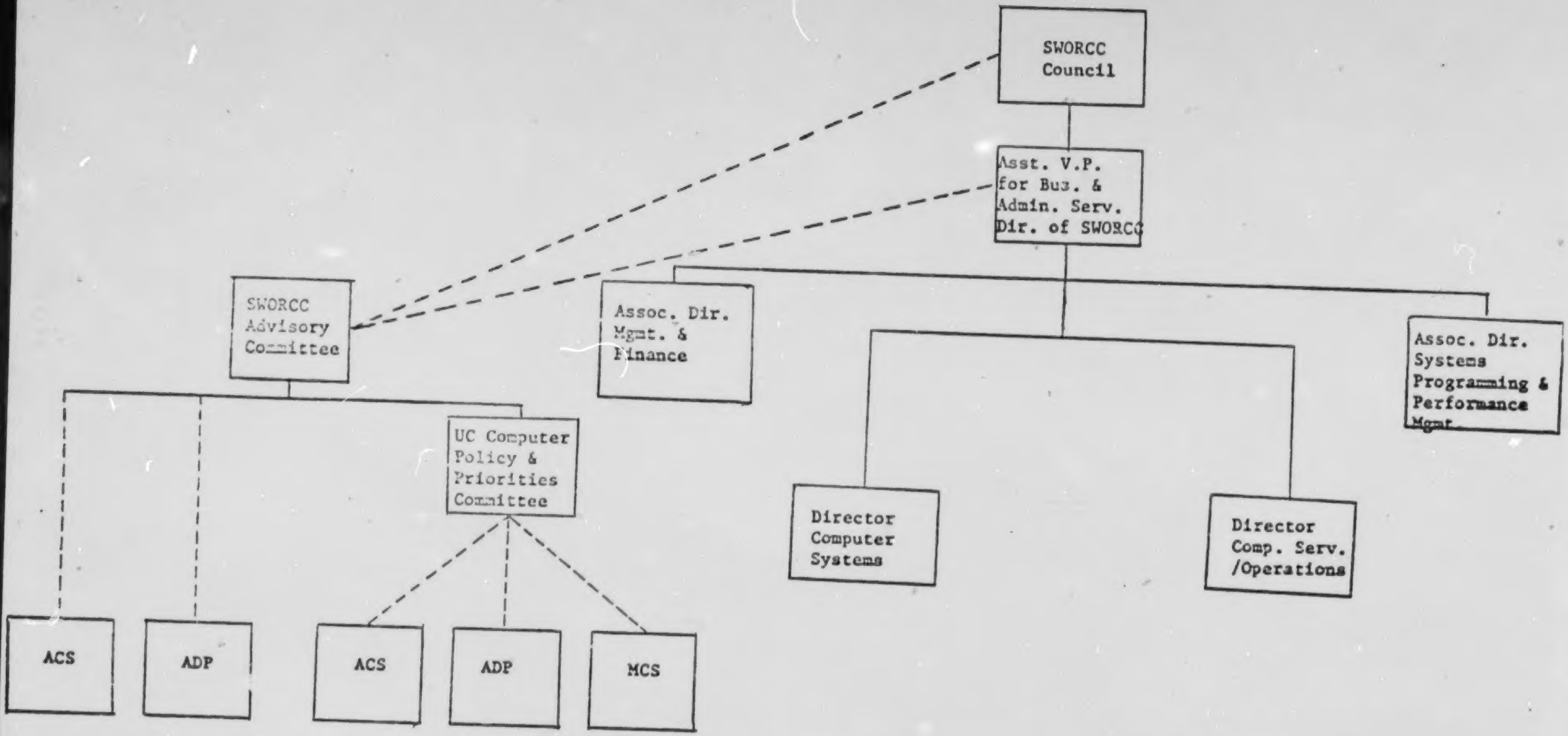
B. Current Status

SWORCC operates an Amdahl 470 V/6 at its central facility located in the U.C. Medical Center with nine high-speed Remote Job Entry Stations and 200 low-speed interactive terminals located on the U.C. and M.U. campuses as well as at other user locations. This Amdahl 470 (plug-to-plug compatible with the IBM 360/370 systems) has over 4 million bytes of core storage with CDC disks, (3.6 billion bytes), CDC mass storage (16 billion bytes), 12 IBM magnetic tape drives, plus a variety of peripheral equipment. SWORCC's total budget is over $6 million for the 1976-77 fiscal year.

SWORCC has two major divisions with other support units and a series of advisory committees, as shown in the organization chart, Figure 1. The Computer Operations/Services Division is responsible for providing computer services to all SWORCC users. This includes scheduling and operation of the central

FIGURE 1

SWORCC ORGANIZATION CHART


SWORCC Council
Asst. V.P. for Bus. & Admin. Serv. Dir. of SWORCC
SWORCC Advisory Committee
Assoc. Dir. Mgmt. & Finance
Assoc. Dir. Systems Programming & Performance Mgmt.
UC Computer Policy & Priorities Committee
Director Computer Systems
Director Comp. Serv. /Operations
ACS
ADP
ACS
ADP
MCS

facility and some of the remote facilities as well as management of the data entry function, the U.C. student/faculty input/output function, and the U.C. administrative data processing function. The Computer Systems Division is responsible for providing systems analysis and programming services, as well as some clerical support services to U.C., administrative, academic and medical, and all other SWORCC users except M.U., who has its own staff of programmers and analysts. This paper is a discussion of the approaches used in the management of the Computer Systems Division.

The SWORCC Council is the policy and decision making group for SWORCC. It is made up of two Vice-Presidents from U.C. and two from M.U. The SWORCC Policy Committee consists of five members from U.C. and five from M.U., representing both academic and administrative interests on the two campuses. Its chief role is to provide support and advice to SWORCC on operational and procedural matters.

The U.C. Advisory Committee structure is responsible for the allocation of computer resources supported by U.C. General Funds to the various divisions and departments. The members of each Committee are representatives of the users in that particular area and are appointed by the appropriate University officer. They meet regularly to review the status of computer services in their area and to set priorities in those cases where there are competing demands for scarce resources.

C. Type of Projects

The Computer Systems Division has grown from a staff of 58 in 1974 to 134 in 1976. This staff is broken down as follows:

	1974	1976
Programmer/Analysts	44	90
Billable Clerks	3	26
Managers	7	10
Support Clerks	4	8
Total	58	134

Current projections indicate continued growth in the number of staff.

The following is a general summary of the types of services provided:

1. U.C. General Funds - General Funds were allocated to support 23 programmer/analyst Full-Time Equivalents (FTE's) in 1976-77. This allocation was further broken down by the U.C. Computer Budget and Priorities Committee as follows:

   a. Administrative Data Processing (ADP) - 16 FTE's - supporting admissions, registration, student financial aid, accounting, budget, payroll, student accounts, development/alumni, personnel, planning, and the library. The assignment of these FTE's is controlled by the U.C. ADP Computer Services Advisory Committee.

   b. Academic Computer Services (ACS) - 5 FTE's - supporting non-medical research and instruction including consulting, computer assisted instruction, and a variety of other projects. The assignment of these FTE's is controlled by the U.C. ACS Advisory Committee.

   c. Medical Computer Services (MCS) - 2 FTE's - supporting medical research and instruction including consulting, data analysis, computer assisted instruction, and a variety of other projects. The assignment of these FTE's is controlled by the U.C. MCS Advisory Committee.

2. U.C. Non-General Funds - Support is provided upon request to U.C. organizational units who provide payments from grants or contracts, or other non-general funds accounts, and to U.C. auxiliary units such as the hospital, the bookstore, and the residence halls.

3. Users other than U.C. or M.U. - The principal growth in the Computer Systems Division has been in the area of non-university users, primarily the federal government. The two biggest single users are the Environmental Protection Agency, Environmental Research Center (EPA-ERC), in Cincinnati and the National Institute for Occupational Safety and Health (NIOSH), in Cincinnati.

   a. EPA-ERC - Based on individual task orders, SWORCC supports EPA-ERC at the level of 1 manager, 15 analyst/programmers, and 4 clerks. This support involves both scientific and administrative systems, and includes tasks ranging from computer seminars to laboratory automation to modeling and simulation to library automation to word processing. 56 separate tasks were ordered in 1975-76 and over 30 have been ordered since the contract award of July 1, 1976, in the 1976-77 year. The majority of this work utilizes EPA computers (IBM 370 and Univac 1110) and a variety of software (Fortran, COBOL, System 2000).

b. NIOSH - SWORCC provides NIOSH with systems analysis and programming, as well as data reduction and analysis, data entry, and data processing services utilizing SWORCC's computer. These services support NIOSH in its studies or the environmental and safety conditions of a variety of industries.

c. Other Federal Agencies - SWORCC provides services to a number of other federal agencies including the United States Postal Service, Wright-Patterson Air Force Base, the Naval Avionics Facility and the U.S. Civil Service Commission of Dallas, Texas. These tasks have involved a variety of applications (e.g. Zip Code Conversion, cost systems, tracking systems, minicomputer seminars), a variety of software (COBOL, Fortran, System 2000) and hardware (IBM 360/370, CDC 6600, H-635).

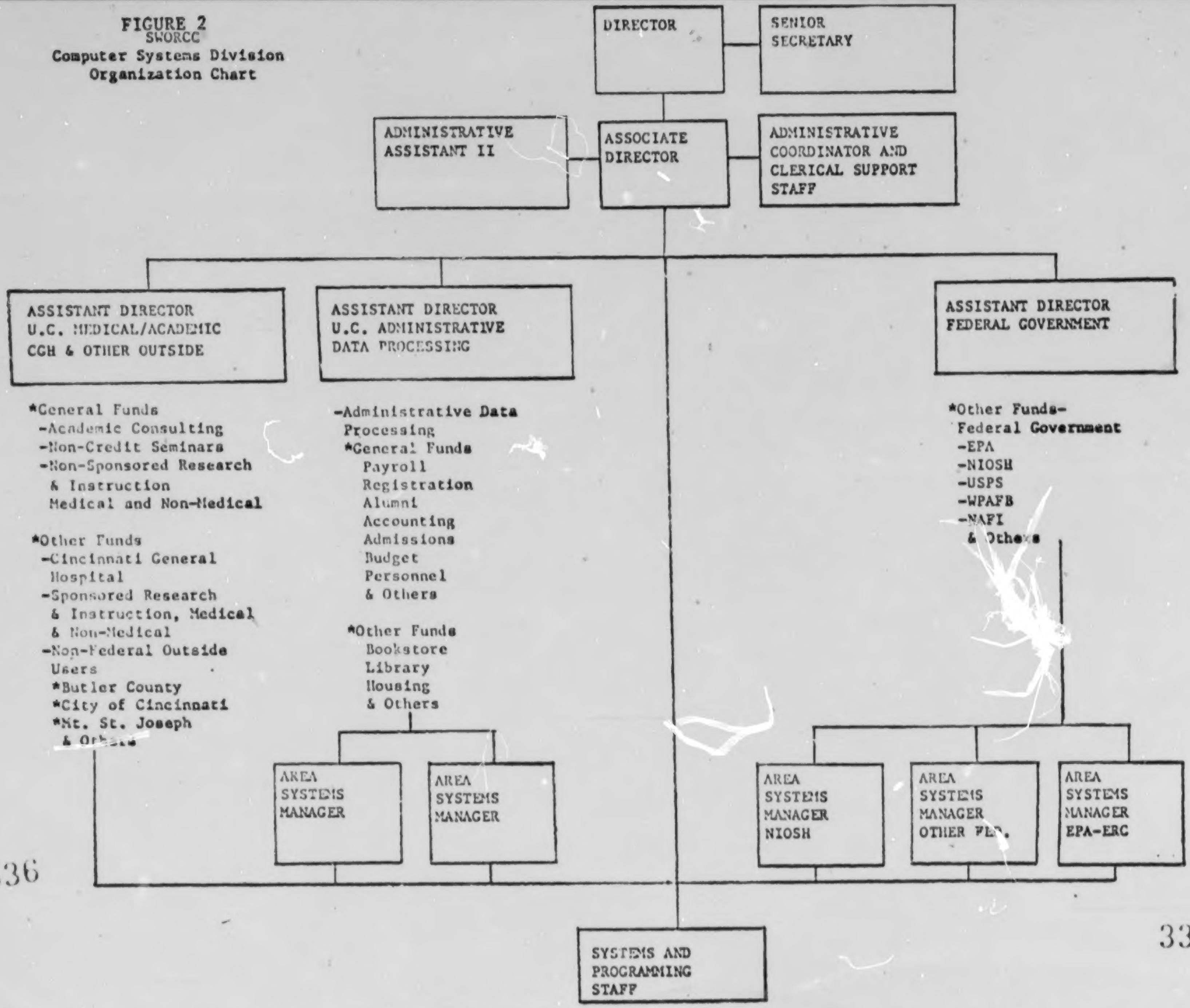
d. Non-Federal Agencies - SWORCC provides systems and programming support to non-federal, non-profit organizations including the Cincinnati Board of Health, Hamilton County Mental Health, City of Cincinnati Family and Business Relocation Departments and Queen City Metro. These activities include a variety of application areas requiring a variety of skills.

D. Organizational Structure

The Computer Systems Division (CSD) is organized to respond to the varied and dynamic needs described above, as shown in the organization chart of the CSD, Figure 2.

The Director of the CSD is responsible for the overall direction of the division and concentrates on planning and budgeting, user liaison, the development of new users, and assisting the Director of SWORCC in the

FIGURE 2
SWORCC
Computer Systems Division
Organization Chart


DIRECTOR
SENIOR SECRETARY
ADMINISTRATIVE ASSISTANT II
ASSOCIATE DIRECTOR
ADMINISTRATIVE COORDINATOR AND CLERICAL SUPPORT STAFF
ASSISTANT DIRECTOR U.C. MEDICAL/ACADEMIC CGH & OTHER OUTSIDE
ASSISTANT DIRECTOR U.C. ADMINISTRATIVE DATA PROCESSING
ASSISTANT DIRECTOR FEDERAL GOVERNMENT
*General Funds
-Academic Consulting
-Non-Credit Seminars
-Non-Sponsored Research & Instruction Medical and Non-Medical
*Other Funds
-Cincinnati General Hospital
-Sponsored Research & Instruction, Medical & Non-Medical
-Non-Federal Outside Users
*Butler County
*City of Cincinnati
*Mt. St. Joseph
& Others
-Administrative Data Processing
*General Funds
Payroll
Registration
Alumni
Accounting
Admissions
Budget
Personnel
& Others
*Other Funds
Bookstore
Library
Housing
& Others
*Other Funds-Federal Government
-EPA
-NIOSH
-USPS
-WPAFB
-NAFI
& Others
AREA SYSTEMS MANAGER
AREA SYSTEMS MANAGER
AREA SYSTEMS MANAGER NIOSH
AREA SYSTEMS MANAGER OTHER FED.
AREA SYSTEMS MANAGER EPA-ERC
SYSTEMS AND PROGRAMMING STAFF

planning and management of SWORCC. The Associate Director of the CSD emphasizes the management of personnel and other internal administrative matters. The Director has line authority in terms of projects and users and the Associate Director has line authority in personnel and administrative areas. Theoretically, all staff are available for assignment to any area based on the needs of users and SWORCC, and the qualifications and interests of the staff person. Where practical and feasible, staff are assigned to an area over a prolonged period of time. These staff represent a core group for each manager to draw on.

The Assistant Director, and his Area Systems Manager(s), are responsible for providing services to specific groups of users. This includes working with the user in determining his needs, working with the Associate Director in staff assignments, and then managing the actual projects which are undertaken.

Each staff member is assigned to one primary manager who is responsible for resolving any conflicts, performing evaluations, and providing a direct person-to-person relationship. However, a staff member may work on several projects for different managers at the same time. The primary manager is selected based on projections that the staff member will work on projects in his area 50% or more during the next three months.

III. TECHNIQUES AND PROCEDURES

A. Fiscal Year Planning and Budgeting

The planning for projects and staff in the U.C. General Funds area for each fiscal year involves the initial allocation of U.C. General Funds to SWORCC and then the assignment of these funds to the advisory committees. Each advisory committee then allocates the staff to the appropriate projects. This is a relatively stable process and is normally completed during the spring of each year. It involves a continuation of previous commitments in many cases. However, because the demand does normally exceed the supply, this process requires some very difficult resource allocation problems especially in the ADP area. This is clearly the responsibility of the advisory committees.

Planning for non-General Funds projects is much more difficult and dynamic. Most of the activities in this area require an immediate response to a user request, and it is difficult to anticipate these requests. However, an effort is made each year to project user needs and translate these into staff requirements.

B. Effort Reporting and Projections

Each staff member submits a report of time worked each week by project, function, and day. (See Attachment 1 for copy of form used.) These reports are the basic input to a computer system in which time is summarized by project and by staff person, and resulting reports are distributed to all CSD managers weekly. (See Attachment 2 for sample pages from this weekly report.) This report is used by each manager as a quick way of assuring that each staff person is working on the right projects, and that time is being assigned properly to indirect accounts (e.g. vacation, training, etc.).

This system produces a report at the end of each month showing the time worked in the month, as well as for the fiscal year to date, and since the system was implemented. (See Attachment 3 for sample pages from monthly report.) There is a report in sequence by project and one in sequence by staff person. The report by staff person also shows the percentage of directly chargeable time for each project and shows the projected percentage for that staff member for that month and for the next two months. The managers use these reports as turnaround documents entering projections for each staff person for each project for the next three months. An updated report is then produced showing the new projections. The reports are also used to monitor and control project costs as compared to original projections and to measure the performance of individuals. They are also used as a historical basis for estimating costs for new projects. Each staff member receives a copy of his report showing how he spent his time and how his time is projected for the next three months.

Managers can submit new needs by using dummy identification numbers and entering projections for future months. The Associate Director then uses the final monthly report to identify those staff members who will begin to have time available in future months and those projects which have a need for additional personnel.

C. Meeting New Needs

Two other computer systems are used to supplement the Effort Reporting and Projection System. One is the Personnel Complement System which consists of a record for each staff member including any open positions. This assists CSD managers in maintaining the current status of present staff and openings for recruiting purposes. The second system is the Skills Inventory System which maintains a record of the skills possessed by each staff member in terms of hardware, software, languages, and applications. Reports are produced by individual and by skill to provide easy access to answer any type of question concerning SWORCC staff capability. (See Attachment 4 for sample pages from Skills Inventory reports.) The system is updated with new staff on arrival and quarterly for existing staff.

The following are the steps in identifying and assigning a staff member to meet a new need:

1. The Area Systems Manager will look to his core group of people for a person available.

2. If the appropriate person is not identified, the manager submits the requirement to the Associate Director for assistance. The Skills Inventory and the Monthly Projections are used to try to identify a person in another area to meet the need. If one is identified, negotiations are undertaken with the appropriate managers to effect the change.

3. If no staff person is selected, the possibility of utilizing staff in other SWORCC divisions/departments and/or the possibility of using U.C. faculty or students, is pursued. If still not successful at this point, it may be necessary to consider overall priorties, and insist that an area free up personnel from other tasks to meet this new need.

4. The last possibility considered is recruiting new personnel to meet the need. Because of the rapid growth of SWORCC and the CSD, recruiting is an on-going function which is the responsibility of the Associate Director. Any new need is factored into this function and personnel brought on board as quickly as possible.

V. Conclusion

Managing a staff of this size in a shared environment is a challenging activity. It is an imperfect process which requires compromise, cooperation, and understanding by managers and staff. Users must be cooperative and understanding, and on occasion, willing to compromise. It presents many different kinds of problems, the solution to which can be summarized as follows:

> "Having the properly qualified, motivated, and managed staff personnel available to meet a user's need within the users time constraints."

SWORCC has been successful in providing these services using the techniques described. CSD managers are constantly reviewing and improving these techniques and procedures. At this time, the systems are being integrated and refined, and serious consideration is being given to adding the missing elements of project management (e.g. schedules, milestones, activity interdependencies, etc.) to the overall system. The approaches to management will continue to evolve to adapt to the dynamic nature of the SWORCC environment.

SWORCC COMPUTER SYSTEMS DIVISION EFFORT REPORTING

EF1 (CC 1-3)

NAME: Social Security Number: (CC 4-12) Week Ending: (CC 13-18)

PROJECT DESCRIPTION	CC 19-24 PROJECT NUMBER	CC 25-27 SUB PROJECT	CC 28-35 PROGRAM NUMBER	CC 36-37 FUNCTION	CC 38-40 % COMPLETE	HOURS							
						CC 41-43 SUN	CC 44-46 MON	CC 47-49 TUE	CC 50-52 WED	CC 53-55 THUR	CC 56-58 FRI	CC 53-61 SAT	CC 62- TOTAL
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evised: 3/18/74			DAILY TOTALS			.	.	.	.	.	.	.	

351

Attachment 1

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PAGE:  17            SWORCC COMPUTER SYSTEMS DIVISION             11/23/76

                            EFFORT BY PROJECT

                              WEEKLY REPORT

PROJECT #  A35711    CHARGE/CREDIT                    WEEK ENDING 11/2 /76

                     EMPLOYEE              SUB-PROJECT #       HOURS

                     HELEN BUCKHORST                             8.0

                     DAVID MEYERS                               23.0

                     ROBERT LAUX                                14.0

                     MARK YOUNG                                 10.0

                     THOMAS KOERNER                             24.0

                     MARK LAMIER                010              6.0

                     DAVID MEYERS               010             17.0

                     MARK YOUNG                 010             30.0

                     THOMAS KOERNER             010             16.0

 *** SUB-PROJECT TOTAL ***                                      69.0

****    TOTAL PROJECT    ****                                  148.0
```

Attachment 2

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PAGE:  68                                  SWORCC COMPUTER SYSTEMS DIVISION                              11/23/76

                                                 EFFORT BY EMPLOYEE

                                                   WEEKLY REPORT
 ROBERT LAUX                        289-40-3488                                 WEEK ENDING 11/20/76

 PROJECT DESCRIPTION                    PROJECT #  SUB-PROJECT #  PROGRAM #  FUNCTION  HOURS  % COMPLETE

 A&S DEGREE ADVISING                     A33340                                  01        2.5
 A&S DEGREE ADVISING                     A33340                                  02       14.5

*** PROJECT TOTAL ***                                                                     17.0***

 SECURITIES INVENTORY & ANALYSIS SYSTEM  A35610                                  01        2.0
 SECURITIES INVENTORY & ANALYSIS SYSTEM  A35610                                  02        7.0

*** PROJECT TOTAL ***                                                                      9.0***

 CHARGE/CREDIT                           A35711                                  06        3.5
 CHARGE/CREDIT                           A35711                                  07       10.5

*** PROJECT TOTAL ***                                                                     14.0***

**** TOTAL EFFORT ****                                                                    40.0****
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353

346

345

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                              SWORCC COMPUTER SYSTEMS DIVISION                                        11/15/76
                            MONTHLY EFFCRT REPORT WITH PROJECTION
                                     BY STAFF MEMBER

295-52-3089  BASSETT , ROBIN S                                                                        PAGE  10

                                         PROJECT            HOURS TO DATE            OCTOBER          PROJECTED TIME
PROJECT DESCRIPTION                   NO.   SUB. WK.CL.    PROJECT      FROM 7/1    ACTUAL PROJECTED    NOV   DEC   JAN
                                                                                  TIME    %     %

INSTITUTIONAL STUDY                  A30408        02       796.5       153.0     12.5    8              30    30    30
                      TOTAL PROJECT*                        796.5*      153.0*    12.5*   8              30    30    30

FACULTY EFFORT REPORTING             A34971        02       915.4       133.5     66.0   43    30        30    30    30
                      TOTAL PROJECT*                        915.4*      133.5*    66.0*  43    30        30    30    30

PRCGRAM EUDGETING                    A35082        02       642.0        92.5       .0         40        40    40    40
                      TOTAL PROJECT*                        642.0*       92.5*      .0*        40        40    40    40

RES RGNTS PREDICTION MODEL           A35084        02       384.5        89.5      6.5    5
                                     A35084-001    02       898.6          .0       .0
                      TOTAL PROJECT*                      1,263.1*       89.5*     6.5*   5

PAYROLL                              A35700        02          .0          .0       .0
                      TOTAL PROJECT*                           .0*         .0*      .0*

MIS/FR                               A35721        02       109.5       102.5     43.5   28
                      TOTAL PROJECT*                        109.5*      102.5*    43.5*  28

RETIREMENT PROJECTIONS               A35771        02        10.0        10.0     10.0    6    30
                      TOTAL PROJECT*                         10.0*       10.0*    10.0*   6    30

SYMAP PROJECT FOR URBAN DEVELOPMENT  D41016        02        16.0        16.0     16.0   10
                      TOTAL PROJECT*                         16.0*       16.0*    16.0*  10

NCN-BILLABLE EFFCRT (X10000)         X10000        02       854.3        29.0      5.5
                      TOTAL PROJECT*                        854.3*       29.0*     5.5*

INACTIVE PROJECTS                    X99999                 737.7          .0       .0
                      TOTAL PROJECT*                        737.7*         .0*      .0*

                        GRAND TOTAL**                     5,364.5**     626.0*   160.0* 100   100       100   100   100
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Attachment 3

SWORCC COMPUTER SYSTEM DIVISION
MONTHLY EFFORT REPORT WITH PROJECTION
BY PROJECT

11/15/76

RETIREMENT PROJECTIONS
A35771-
CC 1-6 CC 7-9

NAME	WORK CLASS	SS# CC 10-18	PROJECT TO DATE	YEAR TO DATE	OCT			PROJECTED FTE		
					HOURS	%	PROJ	NOV CC 19-21	DEC CC 22-24	JAN CC 25-27
BASSETT , ROBIN S	02	295-52-3089	10.0	10.0	10.0	6	30			
BOCKHORST , HELEN	01	158-18-3896	42.0	42.0	42.0	35	30			
GEHRING , MAE	04	296-16-0995	122.5	122.5	122.5	88	40	30	10	
JENIKE , PATRICIA	02	272-46-1766	17.5	17.5	17.5	12	30			
****TOTALS****			192.0	192.0	192.0	141	130	30	10	

SKILLS INVENTORY 08/09/76

CASEBERE RICK

********HARDWARE	APPLICATION	TEACH	DESIGN	PROGRAM	OPERATE	MAINTAIN
BURROUGHS 3500-4700		YES	EXPERT	EXPERT	EXPERT	
BURROUGHS 6700-7700			EXPERIENCED	EXPERIENCED	TRAINEE	
IBM 370/168			EXPERIENCED	EXPERIENCED		
NOVA		YES	TRAINEE	EXPERIENCED	TRAINEE	
********LANGUAGE						
ALGOL				EXPERIENCED		EXPERIENCED
APL				EXPERIENCED		EXPERIENCED
ASSEMBLER				EXPERIENCED		EXPERIENCED
COBOL				EXPERT		EXPERT
FORTRAN				EXPERIENCED		EXPERIENCED
JCL-370/OS				EXPERIENCED		EXPERIENCED
NOVA ASSEMBLER				EXPERIENCED		EXPERIENCED
PL/I				EXPERIENCED		EXPERIENCED
********SOFTWARE						
APL			EXPERIENCED	EXPERIENCED		
CRJE			EXPERIENCED	EXPERIENCED		
EASYTRIEVE			EXPERIENCED	EXPERIENCED		
GPSS			EXPERIENCED	EXPERIENCED		
IBM OS UTILITIES			EXPERIENCED	EXPERIENCED		
OS 360/370			EXPERIENCED	EXPERIENCED		
SPSS			EXPERIENCED	EXPERIENCED		
SYMAP			EXPERIENCED	EXPERIENCED		
******** AREA						
NIOSH	CLINICAL INVESTIGATI		EXPERT	EXPERT		

Attachment 4

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                                                           SKILLS INVENTORY                          08/09/76

                                                           ****HARDWARE****

****HARDWARE****                                         NAME         TEACH   DESIGN         PROGRAM       OPERATE       MAINTAIN

                                                 STANTON, GEORGE L.            EXPERT         EXPERT

  IBM 7074                                       GEHRING MAE                   EXPERT         EXPERT        EXPERT

  IBM 7080                                       KRAFT, ROBERT G             EXPERIENCED    EXPERIENCED

                                                 STAFFORD TOM                                 TRAINEE

  INTEL 8008 MICRPROCE                           FALLON FRAN                                  TRAINEE

  INTERTRAN MINI                                 RAY HEINRICH                                             EXPERIENCED

  LOCKHEED MAC-16                                BECKER TIMOTHY L                             EXPERT        EXPERT

  MODCOMP MINIS                                  FRITZ, JOE                    EXPERT         EXPERT        EXPERT

  NCR CENTURY 100/200                            SMITH ROGER                                  TRAINEE       TRAINEE

  NOVA                                           CASEBERE RICK         YES     TRAINEE      EXPERIENCED     TRAINEE

  NUCLEAR DATA 810                               BECKER TIMOTHY L                             EXPERT        EXPERT

  OPSCAN                                         QUINN, MARY                                EXPERIENCED

  PDP 11                                         CAMERY R MICHAEL                           EXPERIENCED

                                                 CHASE TIM                   EXPERIENCED      EXPERT        TRAINEE

  PDP 11/40                                      KUEHNLENZ, GARY W           EXPERIENCED      EXPERT        EXPERT

  PDP 8                                          WOODS HOWARD          YES     EXPERT         EXPERT        EXPERT

  PDP-8                                          JEE, DANNY                  EXPERIENCED      EXPERT

  PDP-8/I                                        JEE, DANNY                  EXPERIENCED      EXPERT

  PDP16                                          CHASE TIM                                    TRAINEE

                                                 CORBETT, KARL                 TRAINEE      EXPERIENCED

                                                 FISH GREG                     EXPERT         EXPERT

                                                 FRITZ, JOE            YES     EXPERT         EXPERT

                                                 JEE, DANNY                  EXPERIENCED      EXPERT

                                                 LEWIS JAMES                                  TRAINEE

                                                 SMITH ROGER                   TRAINEE      EXPERIENCED

                                                 WILSON, JACK M              EXPERIENCED    EXPERIENCED     TRAINEE
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                                   SKILLS INVENTORY                        08/09/76

                                   ****LANGUAGE****
****LANGUAGE****                   NAME              TEACH   DESIGN      PROGRAM       OPERATE      MAINTAIN

                               WOODS HOWARD                                                       EXPERIENCED

                               YOUNG MARK                              TRAINEE

  COGAR ASSEMBLER              FIRMENT MIKE                          EXPERIENCED                  EXPERIENCED

  COMPASS (CDC ASSEMBL         WILSON, JACK M                        EXPERIENCED                  EXPERIENCED

  COURSE*WRITER                BOLTON, ALEXANDRA                     EXPERIENCED                    EXPERT

  EASY CODER                   STANTON, GEORGE L.                    EXPERIENCED                  EXPERIENCED

  EASYCODER                    LIPPOLIS MICHAEL                        TRAINEE                      TRAINEE

  ECL - UNIVAC                 WOODS HOWARD                            TRAINEE

  EXEC8-UNIVAC                 SMITH ROGER                             EXPERT                       EXPERT

  FORMAC                       MEYERS, DAVID          YES            EXPERIENCED                  EXPERIENCED

  FORTRAN                      ABRAHAMSON DAVID       YES            EXPERIENCED                  EXPERIENCED

                               BASSETT ROBIN                           TRAINEE                      TRAINEE

                               BECKER TIMOTHY L                        EXPERT

                               BLATTER, P L                            TRAINEE                      TRAINEE

                               BOLTON, ALEXANDRA                     EXPERIENCED                    EXPERT

                               BUBB MAURY                            EXPERIENCED

                               BUSSMAN BEV                             TRAINEE                      TRAINEE

                               CAMERY R MICHAEL                      EXPERIENCED                  EXPERIENCED

                               CASEBERE RICK                         EXPERIENCED                  EXPERIENCED

                               CASEBERE, KATHY                         TRAINEE                      TRAINEE

                               CHASE TIM                               TRAINEE

                               CLOSE KAREN            YES            EXPERIENCED                  EXPERIENCED

                               COLSHER MICHELLE M                      TRAINEE

                               CORBETT, KARL                           EXPERT                     EXPERIENCED

                               COWPERTHWAITE JAN                     EXPERIENCED                  EXPERIENCED

                               DILG, DENNIS                          EXPERIENCED                  EXPERIENCED
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SKILLS INVENTORY 08/09/76

****SOFTWARE****

****SOFTWARE****	NAME	TEACH	DESIGN	PROGRAM	OPERATE	MAINTAIN
	STANTON, GEORGE L.		EXPERT	EXPERIENCED		
	STUNKEL, JACK C			EXPERIENCED		EXPERIENCED
	WILLIAM KROGH		EXPERIENCED	EXPERIENCED		EXPERT
DUC (UCC)	STUNKEL, JACK C	YES		EXPERIENCED		EXPERIENCED
DYNAMO 2	BOLTON, ALEXANDRA			TRAINEE		TRAINEE
EASY TRIEVE	FALLON FRAN			EXPERIENCED		
	QUINN, MARY		EXPERIENCED	EXPERIENCED		
EASYTRIEVE	BOLTON, ALEXANDRA					TRAINEE
	CASEBERE RICK		EXPERIENCED	EXPERIENCED		
	GEHRING BRUCE			EXPERIENCED		
ECAP	BOLTON, ALEXANDRA					TRAINEE
	WILLIAM KROGH					EXPERIENCED
	WINSTON LOUIS			TRAINEE		TRAINEE
ESCAPE	STUNKEL, JACK C			EXPERIENCED		EXPERIENCED
EXEC 8 - UNIVAC	SMITH ROGER		EXPERT	EXPERT		
EZFORM/PTFORM	KEITH BRUCE O		EXPERIENCED	EXPERIENCED		
FORMAC	BOLTON, ALEXANDRA					TRAINEE
	MEYERS, DAVID	YES		EXPERIENCED		
	WILLIAM KROGH					EXPERIENCED
GPSS	BOLTON, ALEXANDRA					TRAINEE
	CASEBERE RICK		EXPERIENCED	EXPERIENCED		
	EDWARDS MARGIE			TRAINEE		
	FORSYTHE STANLEY		EXPERIENCED	EXPERIENCED		
	LAKE RONALD E		TRAINEE	TRAINEE		TRAINEE
	PREWITT KATHY		TRAINEE	TRAINEE		TRAINEE
	RAY HEINRICH					TRAINEE

SKILLS INVENTORY 08/09/76

**** AREA ****

**** AREA ****	APPLICATION	NAME	TEACH	DESIGN	PROGRAM	OPERATE	MAINTAIN
	SALES BACKORDER	CORBETT, KARL		EXPERIENCED	EXPERT		
	SALES SCHEDULING	CORBETT, KARL		EXPERT	EXPERT		
BUTLER COUNTY	BOARD OF ELECTIONS	LAUX, BOB		TRAINEE	TRAINEE		
CICS CONVERSION	2260'S TO 3270'S	MCFARLAND SHANNON			EXPERT		
DEV ALUMNI	DARK	MCLAUGHLIN CAROLYN			EXPERIENCED		
DEVELOPMENT ALUMNI	ALUMNI-DEVELOPMENT	GARY HUSSONG		TRAINEE	EXPERIENCED		
	ALUMNI-DEVELOPMENT	HARTKEMEYER MARY			TRAINEE		
		JENIKE PATRICIA L			EXPERIENCED		
		MCBREEN BRUCE		EXPERT	EXPERT		
		WEISKITTEL JOLENE		EXPERIENCED	EXPERIENCED		
	DARK	BASSETT ROBIN			TRAINEE		
		BUSSMAN BEV			TRAINEE		
		JENIKE PATRICIA L			EXPERIENCED		
		MCFARLAND SHANNON		EXPERT	EXPERT		
		YUDOVSKY MEL		EXPERT			
DEVELOPMENT/ALUMNI	DARK	STAFFORD TOM		TRAINEE			
DOCUMENTATION		FRANKE, MARGRIT			EXPERIENCED		
EDUCATIONAL	TIME SHARING	FRITZ, JOE		EXPERT	EXPERT		
EFFORT	FACULTY ACTIVITY ANA	BASSETT ROBIN		TRAINEE	EXPERT		
	FACULTY EFFORT SYSTE	BASSETT ROBIN			EXPERT		
	SWORCC EFF REPORTING	BASSETT ROBIN			TRAINEE		
EFFORT REPORTING		STANTON, GEORGE L.		EXPERIENCED			
EPA		WOODS HOWARD		EXPERT			
	ANN ARBOR EMISSIONS	EDWARDS MARGIE		EXPERIENCED	EXPERIENCED		
		FORSYTHE STANLEY		EXPERIENCED	EXPERIENCED		
		LAKE RONALD E		EXPERT	EXPERT		

SECURITY IN THE DATA PROCESSING DEPARTMENT

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Many executives believe that security means only the physical protection of the computer facility. In reality, almost every functional area which creates, processes, or uses data poses security problems. This paper covers the Ernst & Ernst approach to Data Systems Security rather than just Computer Security through a comprehensive review service for clients.

Security in the Data Processing Department

How vulnerable is your data processing system?...What would happen if the information on your computer files were destroyed?...How susceptible is your system to unauthorized penetration?...Could you continue in business if your computer center was suddenly destroyed?

These are the types of questions we continue to ask our client management, for despite all that has been written about potential hazards of computerized records our internal control and EDP reviews, which are integral parts of an audit continue to show us that few companies really know how vulnerable their computer systems may be. Nor do they know how costly human error, fire or loss of data in their computer center can be. Large dollar losses to sabotage by disgruntled employees, accidents, negligence, or fraud are common. For a business or institution highly dependent on a computer, its very survival can, in fact be at stake. Yet, to paraphrase another writer, too often company executives and Boards of Directors continue to play a game of corporation Russian Roulette, that at any moment their management might receive the equivalent of a bullet to the corporate brain, bringing disaster not only to company operations but also to the employees, stockholders, customers and perhaps to dependent segments of the general public; and in today's militant climate the danger of personal liability through legal action by the harmed individuals or groups also exists.

Let us examine some of the factors which make the computer or data systems security area system so important today.

For one thing, more and more reliance is being placed on computers for day-to-day operations. Not only are companies placing their entire management information system at a central location to control day-to-day activities, but also include all of their future plans and planning devices as part of this information system.

This increased operating reliance leaves few if any processing alternatives. In most installations today, manual bypass procedures are no longer practical should a problem arise during computer processing. Seldom are the people skilled in manual processing still around even if old bookkeeping machines and procedures manuals could be found, and this is doubtful.

Today's data systems are also extremely complex. The expanded use of on-line systems, data communications, integrated data bases, and other sophisticated processing techniques has significantly increased the complexity of most computer operations.

Another factor which makes computer security important today is the increasing cost and difficulty of recovering from serious accidental or intentional errors, or from natural disasters. Even if a good backup plan is in existence, the cost to bring it up quickly and to maintain it can be extremely expensive in terms of additional equipment costs and people resources.

In today's computer environment there is also a much higher concentration of risk because so much critical information is now maintained in the relatively small area of a central data processing department.

Finally, as the data processing operation grows, the security exposures increase both in number and in the value of the potential loss, more and more people will be involved thus increasing the odds of fraud, human error or negligence.

In order to better focus on what we are talking about, let's look at a few situations which are relevant to today's topic. Equity Funding is certainly one of the more colorful frauds. Stan Goldblum and his colleagues pulled off the biggest as yet discovered fraud in U.S. History. Among other things, it involved special computer coding of bogus insurance policies. Of over three billion in face value carried on the computer records, only one billion was legitimate. You will see many books and articles written about this master fraud which may mark the point in history when business finally realized that computer-related security risks are something to be reckoned with.

The Equity Funding debacle probably could not have been prevented because of such massive top management collusion, but a good security program would have required that even more people be involved which would have reduced the chance of the fraud going undetected so long.

To put things in perspective, I would like to quote from the "Report of the Special Committee on Equity Funding" of the AICPA: "Much of the publicity about Equity Funding has characterized it as a "computer fraud." It would be more accurate to call it a "computer-assisted fraud." The computer was used, to a large extent, to manipulate files and create detail, designed to conceal the fraud. Much of this processing was performed by personnel from outside the EDP department who were allowed access to computer hardware, software, and files."

More specific information is available from the AICPA "Report of the Special Committee on Equity Funding", and "The Great Wall Street Scandal" by R. L. Dirks and L. Gross.

Another interesting and perhaps even romantic story is that of "Touch Tone" Jerry Schneider. Jerry struck Pacific Telephone for $5 million worth of telephone equipment. He placed orders to the company's warehouses using their touch tone ordering system. He then had the equipment delivered to construction sites throughout the city where his trucks picked them up. He later sold this equipment back to the telephone company.

There are two stories of how he learned to use the touch tone ordering system. One story says that he posed as a journalist for a D.P. magazine and learned how the system worked while gathering details for an article; the other story says that he found an instruction manual in the company's trash.

Jerry's operation was stopped when one of his truck drivers turned him in because Jerry wouldn't give him a raise. Which proves that good employee relations is important regardless of one's profession. Jerry was convicted and drew a sixty-day jail sentence which was reduced to forty days for good behavior. While he was in jail he programmed the county's accounts payable system. Jerry is now a computer security consultant. While I did not have the privilege of seeing the recent TV program featuring Touch Tone Jerry, I understand that he showed that he can still breech the security of a major data system with relative ease.

Certainly one of the more embarrassing fires was the one which struck the data processing center of the IBM Program Information Department in Hawthorne, N.Y. The center was their main storage and shipping point for their systems and applications programs. The fire occurred in 1972 and lasted for over twelve hours. While the fire raged, keyboards were turned into plastic butter and tons of paper were reduced to ashes.

As in the case with many computer-related fires, the fire did not originate in the computer room, but rather it started in a storage area directly below. The fire spread through the air conditioning ducts. The heat generated, which incidentally reached well over 1000°F., caused the majority of damage.

As a result of the fire, IBM lost many master copies of programs. This disaster would have been much worse except that they had a ready disaster and recovery plan which enabled them to resume operations in less than five days.

A good example concerning the type of problem that can occur with inadequate control of the systems development process is the story of the inflated payroll. A manufacturing company was converting an incentive payroll, based on pieces produced rather than hours earned, to a computerized operation. The union contract specified that overtime, holiday, and vacation pay would be based on an employee's average hourly earnings for the previous ten days. An error made in programming the payroll resulted in an inflated average hourly rate being calculated. When management discovered the error and attempted to correct it the union struck the company saying that a precedent has been set.

These are a few examples of problems that can occur as organizations become more dependent on their computer operations. I am sure that all of you have heard many more of these horror stories, some real, some imagined, and some just embellished. Regardless, these problems can be dealt with.

However, it is important to understand that there are no 100 percent answers to computer security.

With this in mind, remember that since management (and I mean management, not just data processing management) has a responsibility to protect the company's assets and they should take a prudent approach in the area of computer security.

Just what is prudence? Prudence is when you trust everybody in a poker game, but cut the cards anyway. It is an attitude that questions anything out of line or suspicious, and it is rejecting slipshod procedures and working habits. Prudence is the basis for any practical and sound security program and includes trying to deal in advance with what might go wrong.

There are certain elements always present in any good security program, whether it be in the area of plant security or computer security. The first element is to deter potential security abuses with psychologically inhibiting factors. The most common form of deterrent is through the use of signs. For example: "No Admittance", "Authorized Personnel Only", etc.

A second feature of any good security program is to protect assets against loss. This may be accomplished by sophisticated surveillance equipment or by mere safeguarding vital records in a fireproof vault.

A good security program should be able to prevent or divert a threat during its implementation. For example, a burglar alarm, a fire alarm, etc.

A good security system should be able to detect potential problems before they become actual problems. For example, a fire detection system can alert personnel to a fire in its incipient stage, thereby allowing them to react before significant damage occurs.

Another element of a good security system is to be able to limit the extent of loss should a risk materialize. A fire extinguishing system for example would attempt to limit the damage should a fire occur in a computer facility.

To be sure that a security program continues to perform at the desired level, the program must have a provision for audit and control on a continuing basis. This would include a good internal audit program in conjunction with external audits or reviews.

An important point to keep in mind while developing a security program is that it should be done within a reasonable cost. No one wants to pay more for a security program than the potential risks one is protecting against. Care should be exercised not to go beyond the point of diminishing returns. This can only be done after careful study.

Let me again re-emphasize that there are no 100 percent answers to computer security - at any cost! In order to provide protection of assets, it is important to have a sound security program.

How then does management go about developing this security program?

There are several steps involved in developing a security program. First management must identify the major areas of concern - where are the risks and exposures?

Second, after identifying particular risks and exposures, management must evaluate the appropriateness of the present system of safeguards. Third, once these potential exposures have been defined, a written plan addressing these concerns should be developed. The exposures should be priority-ranked for implementation purposes. In other words, areas of concern where there is a high risk should be addressed before those representing a lesser risk.

After the plan for the security program has been developed, the fourth step is to implement the plan. When actually implementing this plan, management should attempt to get the full cooperation and participation of all employees. For example, Pan American World Airways, as part of its security program, declared all of its 36,000 employees to be security officers. A tightening of security in all aspects of the airlines operations was seen immediately.

For the security program to be workable, the sixth step is to establish responsibility for the enforcement and control of the program. As the final or seventh step in developing a security program, management must provide an audit for compliance to security procedures and to look for new exposures and problems on a periodic and surprise basis through the use of internal audit and periodic external audits or reviews.

We have found that many companies have people trained in industrial or plant security. However, very few have specialists with the knowledge and experience to review data systems adequately and objectively. For this reason many companies have gone to outside consultants to assist them in this specialized area.

While we can assist clients in all seven steps of a good security program, we have developed an in-depth service covering the first three steps mentioned. Because of the broad scope of the problem which extends beyond the physical aspects of computer security we refer to this service as a Data Systems Security Review. This review is intended to help: (1) Identify risks and exposures, (2) Evaluate the adequacy of current security, and (3) Provide the basis for developing a priority-ranked plan.

Our program has been developed on a national basis; therefore, it is a standardized, uniform approach to security reviews throughout the country. This national commitment also makes it possible for our specialists in this area to review the data systems security area and to reflect changes and improvements to our program on a continuing basis.

Our program is a broad-based, comprehensive review covering eight major, interrelated areas of computer concern. The review is disciplined, conducted by using a comprehensive list of over 500 evaluation points covering the major areas of exposure in data systems security and yet it is customized to meet a company's or institution's specific needs in two ways. First, standard evaluation points are priority-ranked to reflect specific risks and exposures. Then, additional evaluation points are developed to reflect unique aspects of the data processing function.

The scope of our data systems security review include:

- Scope - Personnel Practices
  - The first area is personnel and is concerned with:
    - Organization structure
    - Recruiting techniques
    - Pre- and Post-employment procedures
    - Operating rules
    - And other areas where employee-related problems could potentially disrupt a company's security in the data systems area.

- We evaluate areas such as:
  - Do employment practices reduce the probability of hiring a security risk?
  - Are there special screening procedures for persons holding "Sensitive" data processing positions?
  - Do termination procedures recover ID badges, credit cards, keys, and similar items at time of termination?

- Scope - Physical

  In the area of physical security we are interested in the physical safeguards taken to protect personnel and equipment.

  - We review access control, surveillance equipment, fire prevention and detection systems, alarm systems, and other devices used to protect and safeguard the DP installation.
  - In this area we investigate questions such as:
    - Do existing safeguards adequately limit access to restricted areas?
    - Has equipment been installed to prevent, detect or limit the impact of natural disaster such as fires, floods or earthquakes?
    - How often is the equipment tested?

- Scope - Data, Programs, and Documentation
  - Here we are looking for sufficient documentation, so that data and programs could be reconstructed if necessary.
  - We are also reviewing their protection both on-site and at the backup site to insure protection against manipulation or loss through accidents or willful destruction.

  - This would include program change procedures, documentation standards, data library access controls and other techniques to control and protect records.
  - Here we ask questions like:
    - Is the documentation sufficient to restore lost data programs?
    - Are provisions for the physical protection of data, programs and documentation adequate?

- Scope - Operating
  - Here we are reviewing safeguards over the information utilized by the DP facility.
  - We review things such as:
    - Data and output handling
    - Operator controls
    - Job controls
    - Record keeping
    - Internal audit procedures
  - And we would determine answers to questions such as:
    - Are operating personnel adequately supervised?
    - Are there techniques for assuring the accuracy and completeness of data being processed?

- Scope - Backup
  - Backup provisions for data, programs and documentation are reviewed to ascertain that the proper copies are retained and that they provide the means to adequately recover in the case of an emergency.

  - We review backup to insure that alternate operating plans exist so that in the event of an emergency the EDP installation could continue to function.
  - In this area we question items such as:
    - Are there alternate processing resources available if there is an extended loss of computer facilities.
    - Are there backup copies of data, programs and documentation to allow an effective recovery from a disaster such as fire or flood? Have these plans been tested?

- Scope - Development
  - In this area, we review the development activity of computer systems both from the DP side and from the standpoint of user department needs. It includes a review of:
    - Specification controls
    - Project review procedures
    - Programming standards and practices
    - Testing techniques
  - We question situations and procedures such as:
    - Have there been situations where it took several months to work the bugs out of a newly-automated application?
    - Does the company's internal audit review or assist in the design of control procedures for new systems?

- Scope - Insurance
  - Insurance is a relatively new area for DP installations.
  - We review DP insurance for:
    - The scope of coverages

- Any exclusions written into the policies, and
- Compliance requirements - to be sure all requirements are being met for continued coverage.

- Insurance is reviewed to be sure there is an adequate second line of defense should the company lose some portion or all of its DP facility. However, it does not eliminate the need for a sound security program.

- Scope - Security Program
  - We review a security program to be sure there is a viable plan in writing covering areas such as:
    - Contingency and disaster plans
    - Employee awareness programs
    - Enforcement
    - Other emergency plans, so that if needed they can be employed with the least disruption possible.
  - In this area we would ask things such as:
    - Does the company have formal disaster plans?
    - Have the plans ever been tested?

- Supplemental
  - This is the area where we would expand the evaluation points to cover areas unique to the specific needs of the company.

These, then, are the major areas of concern in computer security that in our opinion are necessary parts of a good systems security review:

Personnel Practices
Physical Safeguards
Data, Programs and Documentation
Operating Procedures
Backup Provisions
Systems Development
Insurance
Security Program and Plans
Supplemental Areas

A Data Systems Security Review whether done internally or by independent, objective third parties should give the company or institution a realistic evaluation based on analysis of exposure and risk; a review of current security posture giving practical recommendations which reflect a philosophy of "Reasonable Assurance" which implies that the cost of a security program should not exceed the potential loss; and a sound basis for developing a priority ranked security plan.

In summary, we would like to say that we believe a data systems security review should have a comprehensive broad-based scope and should be disciplined, tested, and practiced.

As evidenced by Equity Funding, fires, and other security breaches, data systems security is becoming more and more important. Management (and again I restate not just data processing management) must take the initiative to be sure that safeguards are implemented and that security breaches are found and resolved. Although there are no 100 percent answers, it is management's responsibility to exercise due care in providing for the protection of the company's assets.

The problem is a "now" problem and prudent action is needed. We urge all management to take this prudent action and to prevent to the extent possible the continuation of data system security "horror stories".

FAIR INFORMATION PRACTICE LEGISLATION: IMPACT ON HIGHER EDUCATION RECORDS SYSTEMS

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The Federal government has passed several laws regulating the information handling practices of organizations. The Family Educational Rights and Privacy Act of 1974 (also known as the Buckley Amendment) requires all educational institutions receiving Federal funds to subscribe to its provisions. In addition, State and Federal legislation may be extended to cover these institutions in the future. This session dealt with some of the explicit and implicit design and operational requirements imposed by legislation of information practices. For example, accessing, updating, expunging and protecting information will have to be done at the data field level rather than at the record or file level as has traditionally been the case.

The above abstract of this session is included for the interest of the reader. This session was based on a book entitled, The Privacy Act of 1974: A Reference Manual for Compliance by Arthur A. Pushkin and Samuel I. Schaen. For further information, please contact the authors at 7929 Westpark Drive, McLean, Virginia 22101.

SECURITY AND PRIVACY AT A PUBLIC UNIVERSITY

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The data center and the user offices at a public university have a responsibility to maintain security and to protect the privacy of the individuals whose data they process. This persists even though much personal data are accessible in libraries. How to identify "private" data, what security precautions to take to protect these data from being abused, and what are reasonable costs and procedures to provide protection, are questions facing administrators responsible for safeguarding information and equipment. The approaches taken by a team at the University of Illinois to answer these questions are described in this paper.

SECURITY AND PRIVACY AT A PUBLIC UNIVERSITY

Use or misuse of information stored in data banks can affect the welfare and future of every individual in our society. Nevertheless, as odd as it may seem, at present the average citizen does not have a clear definition of all his rights regarding information that is collected about him, how it is treated, or what he can do about its use.

The ethics and standards maintained by universities have for a long time been a major factor in the support of systems to limit the distribution of data which were considered personal or private by an individual. The passage of the Family Educational Rights and Privacy Act of 1974 increased concerns regarding security and privacy in university records. The Act provides among other things that federal funding will be withheld from higher educational institutions which deny a student the right to inspect and challenge the content of his or her cumulative record. In addition, the Act imposes restrictions upon access by others to a student's record without the student's written consent. The realization of the financial impact sent the universities scurrying into investigations of how best to insure that they were complying with the Act.

What is meant when the subject of privacy is addressed? According to the dictionary, privacy is the state of belonging, concerning, or being restricted to only one person or to specific persons. On the other hand, security is defined by Webster as freedom from danger or risk. Clearly, privacy cannot be assured without security.

Today, there are six federal statutes that contain aspects of privacy protection:

- The Freedom of Information Act
- The Fair Credit Reporting Act
- The Family Educational Rights and Privacy Act
- The Privacy Act of 1974
- The Fair Credit Billing Act
- The Equal Opportunity Act

The Privacy Act of 1974 applies only to the Federal government, whereas the others are general. At the state level, we find versions of these being adopted (e.g., Arkansas, Massachusetts, Ohio).

A general notion reflected by legislation suggests that, "Privacy refers to the rights of individuals and organizations to determine for themselves when, how, and to what extent information about them is to be transmitted to others."(1) This is consistent with the definition of privacy which implies that the information is under control, or at least cognizance, of the individual specified. The individual is justly concerned with the type of information in files, the accuracy, integrity, completeness, timeliness, and relevance of the information as well as its use. Security, on the other hand, implies physical protection of the information or "protection of data against accidental or intentional disclosure to unauthorized persons, or unauthorized modifications."(1)

Both the Privacy Acts and Credit Acts have a direct impact on public universities. In the context of the Privacy Act, it is necessary to define what is meant by "student". At the University of Illinois a "student" is defined as, "a person who is or has been in attendance at the University of Illinois, and for whom the University maintains education records or personally identifiable information".(2) The definition includes on-campus, extramural and correspondence course students. The Fair Credit Reporting Act of 1971(3), amongst other things, provides that individuals be informed of the nature and substance of information in their credit files. The University, as an employer and as a creditor maintains records which affect the credit rating of employees and students. Disclosure of information contained in these records must comply with the Fair Credit Reporting Act.

The data center and the user offices at a public university have a responsibility to maintain security and to protect the privacy of the individuals whose data they possess. Figure 1 can serve to illustrate the situation affecting information privacy. Data are collected from an information source or a number of information sources. In the case of students, this might be grades which are submitted by instructors to the department or to the registrar's office. In the financial aids area this might be the basic information that is submitted by parents to the financial aids office. In any event, this information generally is funneled to some data collection point. The data collection point is normally under the control of some user office within the university. From this point data may be accumulated and put into a specified format for processing, or the data may be entered directly to the computer center through a terminal or data entry sheets before processing. In the former case the data may be processed completely within the user office and become part of a physical file. Alternatively, the data may be assembled and forwarded to the data processing office to be formatted and entered into the computer. From the computer, the data are placed in storage, either on tape or on disk before going through processing and then are returned to storage or are forwarded to a legitimate user in the form of a report or display. Although the precautions taken may vary with the form the data are in, the fact remains that the information must be protected.

The Privacy Act of 1974 also created a "Privacy Protection Study Commission" to, "Make a study of data banks, automated data processing programs and information systems of governmental, regional, and private organizations in order to determine standards and procedures to be enforced for the protection of personal privacy." Although the final report of this group is not forthcoming until June of 1977, the issues that it is addressing affect many aspects of daily university life including health records, employment files, personnel files, and issues of confidentiality. Educational Institutions are one of the 14 types of organizations whose record-keeping practices are to be examined.

In view of growing activity at both the federal and state levels, and in view of their historic responsibilities, public universities must be prepared to deal with the problems of privacy, security, and confidentiality. Information which legitimately belongs in the public domain must be specified and separated. In the light of the evolving issues, the public university is faced with the problem of identifying private data, and then considering what security precautions to take to protect these data from being abused. A fundamental question facing the university is, "What reasonable course of procedures can the university provide in order to ensure that the proper safeguards are being taken?".

At the University of Illinois administrative data are processed by a central computer. Figure 2 shows the configuration under which the computer services for administrative data are provided. As shown in the figure, the IBM 370/168 computer is accessed not only by the University offices, but also by external groups such as the Illinois Board of Higher Education, the Illinois Community College Board, and others. The peripherals located at the Center include thirty-eight double capacity 3330 disk drives and twenty-two dual density 3420 tape drives. Approximately 11,000 tapes for various user offices are stored at the Center.

From the data processing point of view, the information privacy diagram can be redrawn as in Figure 3. In this environment the data starts with a prime user who is responsible for the particular information. From there it is transferred in machine readable or other form to the data processing department. The transfer medium may take any number of forms such as direct entry by teleprocessing, or the physical transmission of raw data sheets. Within computer operations that data may be transcribed, stored in the computer or one of its auxiliary units, processed via various programs, or retained in some computer readable form on a file. The data are available to the user on a display, printout, microfiche, or machine-readable forms, if desired. Printed data are normally returned to the user office to be disseminated or used in some specific fashion. At each step of this data journey it is possible that either the physical safety or the integrity of the data can be affected. Figure 4 summarizes the forms in which the data are exposed.

A committee was appointed at the University of Illinois with the charge of:

1) Analyzing the confidentiality and criticality of data.
2) Assessing the vulnerability and risks to which information is exposed.

3) Investigating technological safeguards.

It was agreed that the group would be restricted in scope to deal with those aspects of the charge which related to data processing and the administrative computer facilities.

The committee consisted of representatives of the general University, Personnel, Auditing and Data Processing. The committee decided to adopt a modified business system planning approach in order to determine the need for privacy and data security at the general management level. This implied a top-down approach in which the concerns, as perceived by each of the executives, would be obtained and used as a guide. However, it also implied that the executive interviewed would have to be informed both as to the project objectives and their part. The first phase of the study was designed to identify those areas which are of major concern to top level executives at the University. The plan provided that after a framework of major concerns had been established the study would be extended to lower level executives in order to establish the details.

Executives were invited by a memo from the President's Office to participate. With the invitation they received a copy of a booklet entitled "Data Security and Data Processing", which was issued by the State of Illinois as an executive overview. In addition, the committee made up charts which were put on the wall in the room where the meetings were to be held. These charts served as a basis for reviewing the background and stimulating conversation.

Table 1 lists the captions of charts that were used for establishing background. The first chart contained a statement which reiterated that the principal objective of this phase of the study was to determine the need for privacy and data security as perceived at the general management level. This concern was to be expressed from the viewpoint of the executive being interviewed. The committee expected that dealing with each executive individually in terms of his area of responsibility would yield a series of well-defined concerns.

On the second chart, the interviewees were shown a list of the other people at the executive level that were being interviewed. Thus, in codifying their thoughts, interviewees would be less inclined to anticipate some problem areas which may be covered in the purview of another executive.

Further emphasis was given to the importance of the committee's work by showing a statement which had been issued by the University of Illinois Board of Trustees. This statement essentially authorized the President to promulgate guidelines for the discharge of University of Illinois obligations under the Family Educational Rights and Privacy Act of 1974. The statement was further supported by citing examples where the authorization had already been put into effect.

The remainder of the charts were directed toward the core problem as described. The first of these was a discussion of compliance requirements, which were grouped under the headings:

A) Federal and State Laws.

B) University Policies, Statutes and General Rules.

C) Contractual.

One of the topics discussed was the impact of new legislation which was being considered at both the national and state levels that would permit individuals to have access to their personal files under certain conditions. At the state level Governor Walker had appointed a "Commission on Individual Liberty and Personal Privacy"(4) which drafted a legislative package built on three underlying principals:

1) Informed Consent by the individual.
2) Responsibility for proper use of personal information placed on the collector of the information.
3) Public being informed about the purposes and uses for keeping records.

Speculation of the impact of the package was a manifestation of concern. To help clarify the relative needs to protect information, it was suggested that the executives consider the data as categorized from four different viewpoints:

1) Confidentiality.
2) Criticality.
3) Type and Severity of Risk.
4) Frequency of Risk.

For information given or to be maintained "in confidence", the executives anticipated situations which could raise questions. For example, what is the guideline of "Confidentiality" if a student were to have access to a file in which was included a copy of a letter of recommendation written by a faculty member and requested by the student? Were the contents of that letter to be the property of the professor and not necessarily disclosed to the student, or in fact, should the student have permission to see what's in that letter? Not only students, but employees as well would have access to private files if certain legislation were to be passed as proposed (e.g., H.P. 1984 would create the right for all individuals to have access to their employee personnel files to review all material that either relates to them or has a bearing on their employment status.).

The criticality of data is very clear in terms of an administrator's concern. For example, certain data prematurely disclosed could seriously hamper an administrator's chances to obtain funds for some vital project. Yet, it cannot be denied that guidelines would help in deciding to what extent such data should be protected and to what extent these data are to be considered private. Closely attuned to this question is the type and severity of risk involved in the data being exposed. In one instance, a list may consist of the names of employees in a department. Such data would be referred to as directory information, and not very critical. On the other hand, next to the names may be a list of budgeted salaries. That list may be considered a critical list, with data whose unauthorized use could have severe repercussions. In considering the extent of protection required for data, one must also consider the frequency of which the data are exposed to breaches of privacy or security.

One of the essential parameters governing the total study was to be able to match the safeguards to the categories of concern and the compliance requirements. As a result of this matching procedure, recommendations for administrative action, policies, procedures or technological safeguards would be developed The type and degree of safeguards imposed would be a function of the costs as well as the considerations suggested by the match.

Figure 5 indicates a number of the major causes to which loss of data is attributed. Physical loss can apply to both records and equipment.

The loss can be incurred as a result of either an accidental or premeditated situation. Generally, one can take preventive steps to minimize losses by accidental causes. However, it is not always easy to prevent premeditated damage by an informed person. Appropriate procedural precautions can be helpful in reducing the chance of intentionally inflicted damage. In either case, unless there is some backup, the data are irretrievably lost. Compromised data are not generally irretrievably lost. For example, if a computer printout list is stolen, a duplicate list can be obtained from the computer.

Technological safeguards that are available at the University were reviewed for the interviewee. These included such measures as hardware safeguards, software safeguards, organizational procedures, physical and environmental safeguards, and system design safeguards. For example, the University has provided space where the data tapes and disk files are relatively safe from physical hazard. When data are being processed by the computer or are stored in online files, sign-on procedures provide a modicum of protection for the data via software. The computer room itself is a closed area which can be entered only by people who are recognized or accompanied by a recognized individual. On the other hand, terminals in user offices are not "locked". Such terminals conceivably could be used by an intruder to break security or invade privacy.

The effect of the loss of data is an influencing factor on any decision made to protect data. Some of the questions to be considered for effect of loss of data are:

1) "Is it a handicap to the operation? In particular, will the loss of the data delay performance of a particular function, cause

the abandonment of the operation completely, cause the use of extra resources, or have any other effect which might detract from the smooth conduct of the operation?"

2) "What are the effects on cost to the operation caused by the loss of data?" This includes consideration of whether the loss of data imposes a high cost to reproduce the basic data; whether additional costs are incurred because of a time lag in producing the data; whether a loss of funding from Federal or other agencies could be affected by a loss of the data; or whether any other direct or indirect additional costs would result.

3) "What is the implication of legal exposure?" Associated questions include: "Would the loss of data expose the University to lawsuits? Would these lawsuits be of a nuisance type or would they impose extensive obligations on the University? Would a loss have been the result of direct violation of privacy laws? What liabilities could be incurred other than financial and moral?"

Another area that the administrators were asked to consider in evaluating the security and privacy issue was individual accountability. In this regard the standard questions of who, why, when, what and where were to be considered in evaluating elements of data from the point of view of accountability. Typical "who" questions include, "Who has a need to know?", "Who has a need to change?", "Who has the right to expunge information?". Typical "why" questions include, "Why do they need to know?", "Why must the data be kept or expunged?", "Why must the data be changed?". Typical "when" questions include, "When do they need to know?", "When will the data be changed or deleted?". Typical "what" questions include, "What do they need to know?" and "What are the costs involved in getting the data on a timely basis?". Typical "where" questions include, "Where is the data located?", "Where is the data source located?", "Where is the data to be used?".

Having established the general background for expressing concerns about privacy and security, the committee discussed more specific details with the interviewees. For this purpose, a survey questionnaire was developed. The questionnaire dealt with data in six broad classes: individual student, individual staff, aggregate financial, aggregate institutional, research administration, and academic. The questionnaires were designed to reveal:

1) How critical would it be to the functioning of the University if the data were lost?
2) Does the information have value to a person who might steal it?
3) What is the likelihood of someone using the data for fraud or embezzlement?
4) Would disclosure cause embarrassment or loss to the university?

Figure 6 is the questionnaire that addressed data relevant to the individual student. A similar questionnaire form for the individual staff member data dealt with race/ethnic, marital status, sex, age, salary, citizenship, military background, exam scores, medical records, etc. The aggregate financial data form addressed account budgets, expenditures, obligations, accounts payable, accounts receivable, stores inventories, payroll, financial aid, etc. The aggregate institutional data form addressed instructional units by student level, cost per instructional unit, headcount of majors, enrollment by sex/level/category, degrees granted, grade distribution, student quality measures, classroom availability, timetable, etc. The research administration form addressed outstanding proposals, grants, budgets, agencies, subjects for proposal or grant, expenditures by grant, etc. The academic questionnaire addressed classroom availability, timetable, degree requirements, transfer credit requirements, course descriptions, available degrees, etc. Responses were weighted from one to four as illustrated in Figure 6.

The preliminary results indicated that for the purposes of the study, data could be re-grouped as: 1) Identifiable data on individuals, either staff or student. 2) Financial data. 3) Other data.

Individual data, both staff and student, were the major concern of most administrators. Emphasis was on privacy, especially from the view that the University be in compliance with federal and state laws pertaining to the rights of individuals. Concern was about possible conflicts between privacy/security regulations and other regulations. For example, equal opportunity regulations might require sex information whereas privacy regulations permit the individual to restrict the data that is released to a department. The administrators also expressed a concern that the University has a moral obligation to take measures to insure the security of individual data.

In the financial area, fraud and embezzlement were of the gravest concerns, especially pertaining to accounts payable, accounts receivable, cash receipts and payroll. These concerns are somewhat traditional in that they have been stressed by both internal and external auditors. Much more emphasis was placed on security than on privacy. Loss of financial data could seriously affect the operation of the University and the cost of re-creating this data might be very high. Questions were raised concerning physical security, the adequacy of backup procedures, and the adequacy of control procedures. Theft of data was of some concern, but much less if stolen by copying. Disclosure of financial data was of little concern except in those areas which dealt with the privacy of individuals, such as payroll information.

Other data, generally aggregate in nature, were of little concern if either lost, stolen, or disclosed. Frequently the aggregated information is disseminated, or at least available to a broad group. Academic and aggregate institutional data consistently rated least on the scale of possible concerns.

Having identified the concerns in a top-down approach, priorities for action items and costs associated with these must be identified. A critical review should be directed at minimizing the possibility of a breach of privacy or security, minimizing the effect of compromised or lost data (e.g., keep fires from spreading), and maximizing, within resource constraints (i.e., money, people, facilities, time), the chances to recover from loss of information or breaches of security and privacy. Detailed studies are under way to determine existing administrative, technical and physical safeguards. The areas include a broad range of topics, some of which are shown on Figure 7. Preliminary results have been very encouraging.

From a data processing point of view, one can easily extrapolate that at least twenty-five percent of the cost of system development will be absorbed by considerations associated with security and privacy issues.

In addition, we may be seeing the demise of the "open shop". When one considers the responsibilities of a public university, the issues of security and privacy are highly visible but the associated costs may not be. Existing laws and laws currently being contemplated, at federal, state and local levels, will have an impact on the way information is treated. We are only scraping the surface, but it is necessary for all the public universities to recognize their security/privacy obligations and take necessary steps for meeting these obligations.

The author wishes to acknowledge the contributions of the University of Illinois Administration, the Executive staff, and the other Committee members: R. Franks, D. Hopkin, J. McManus, D. Rubenstein.

References

1) Security, Accuracy, & Privacy in Computer Systems, Prentice Hall, 1973.

2) Interim Guidelines and Regulations for Implementation of The Family Educational Rights and Privacy Act of 1974 - January 24, 1975. J. E. Corbally.

3) The Fair Credit Reporting Act (U.S. Public Law 91-508).

4) "Illinois Commission on Individual Liberty and Personal Privacy". Established by Governor Walker March 1974, Bernard Weisberg, Chairman.

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I. SCOPE OF STUDY

II. INTERVIEWEES

III. U. OF I. BOARD OF TRUSTEES

IV. COMPLIANCE REQUIREMENTS

V. CATEGORIZATION OF DATA

VI. TECHNOLOGY SAFEGUARDS

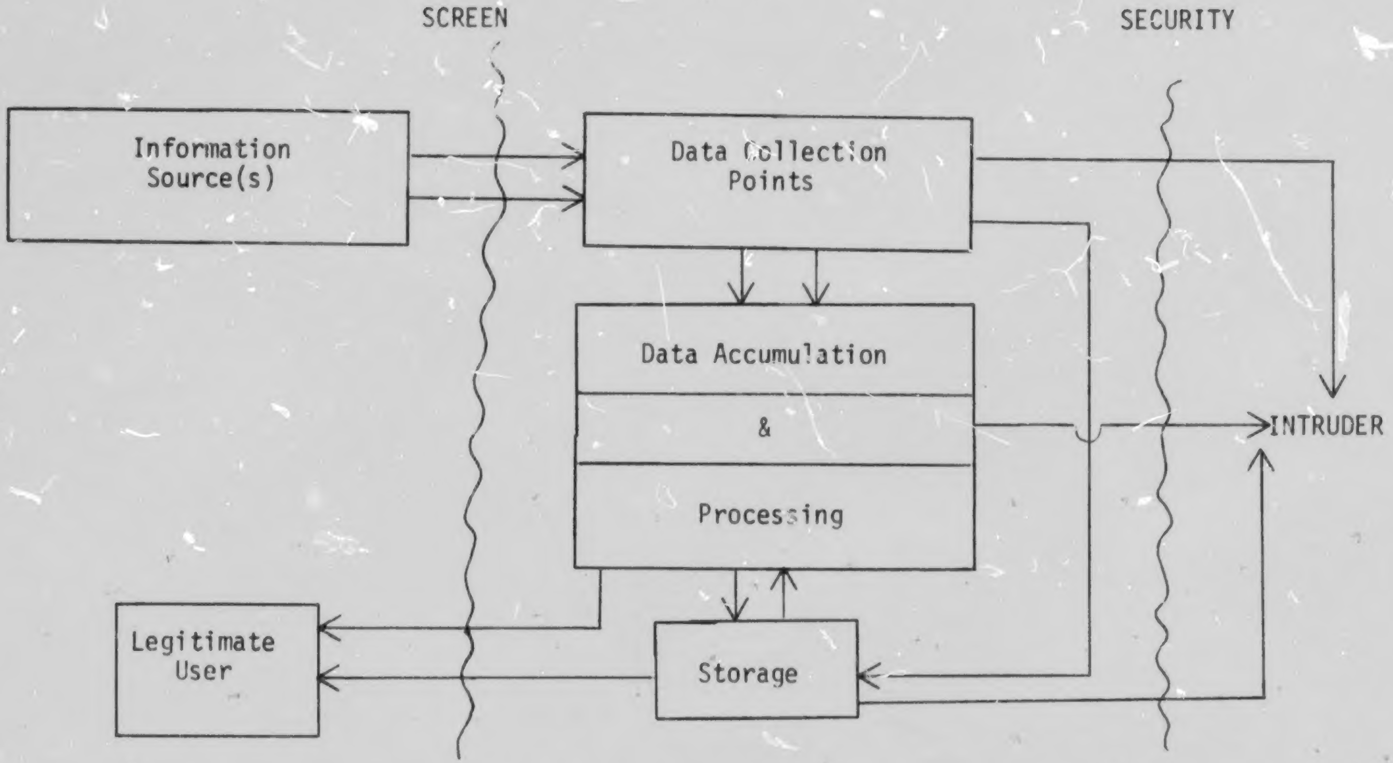
VII. MATCHING SAFEGUARDS TO CATEGORIES

VIII. INDIVIDUAL ACCOUNTABILITY

IX. LOSS OF DATA

CHARTS

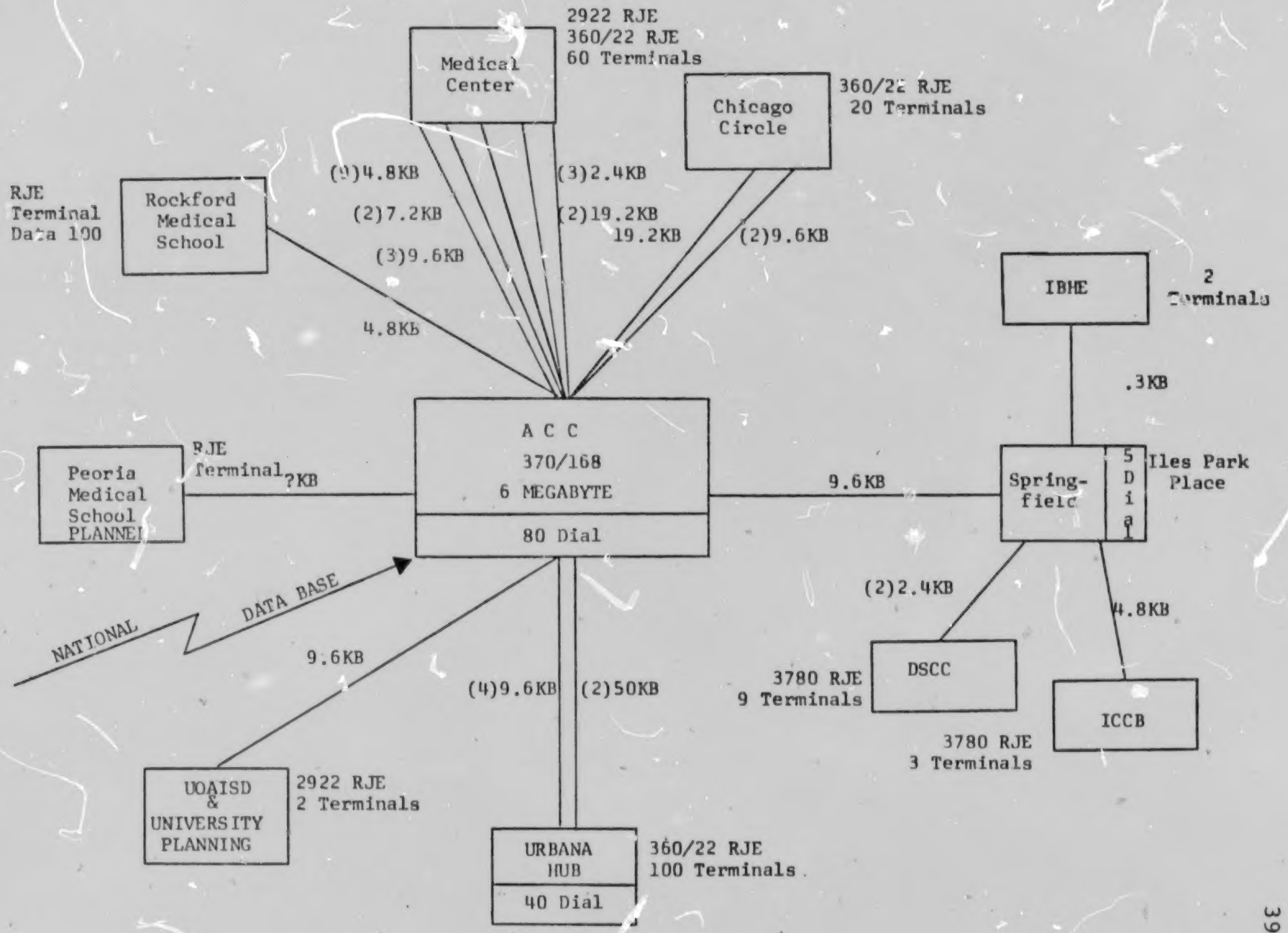
TABLE 1


SCREEN
SECURITY
Information Source(s)
Data Collection Points
Data Accumulation
&
Processing
INTRUDER
Legitimate User
Storage

INFORMATION PRIVACY

FIGURE 1

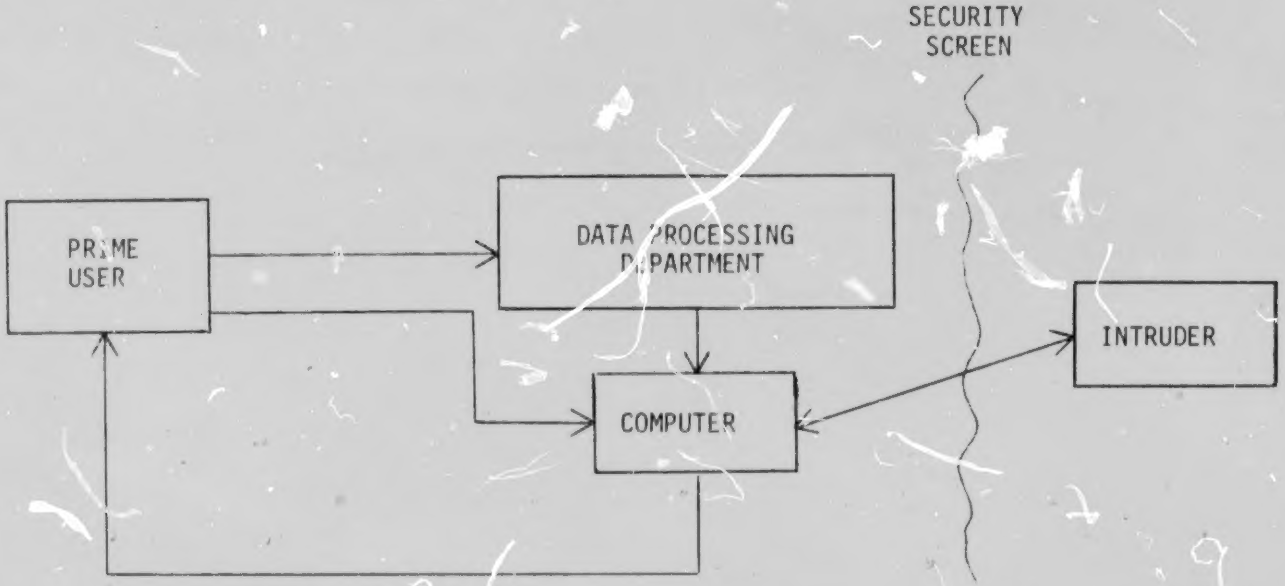
UNIVERSITY OF ILLINOIS ADMINISTRATIVE COMPUTER CENTER NETWORK


Medical Center
2922 RJE
360/22 RJE
60 Terminals
Chicago Circle
360/22 RJE
20 Terminals
RJE
Terminal
Data 100
Rockford Medical School
(9)4.8KB
(2)7.2KB
(3)9.6KB
(3)2.4KB
(2)19.2KB
19.2KB
(2)9.6KB
4.8KB
IBHE
2
Terminals
.3KB
Peoria Medical School PLANNED
RJE
Terminal
?KB
A C C
370/168
6 MEGABYTE
80 Dial
9.6KB
Springfield
5 Dial
Iles Park Place
NATIONAL DATA BASE
9.6KB
(4)9.6KB
(2)50KB
(2)2.4KB
4.8KB
DSCC
3780 RJE
9 Terminals
ICCB
3780 RJE
3 Terminals
UOAISD & UNIVERSITY PLANNING
2922 RJE
2 Terminals
URBANA HUB
40 Dial
360/22 RJE
100 Terminals

Terminal is a hardwired CRT, usually for CICS or IMS.

NOTE: All Dial ups are not identified but approximately 150 terminals will dial into CICS, M204, TSO, and ATMS.

FIGURE 2


SECURITY
SCREEN
PRIME
USER
DATA PROCESSING
DEPARTMENT
COMPUTER
INTRUDER

DATA PROCESSING SECURITY

FIGURE 3

SOURCE DATA	PROCESSED DATA	TRANSMISSION
Keypunched Cards	Disk File	Microwave Signal
Punched Tapes	Tape File	Line Signal
Typed Forms	Printed Material	
Written Forms	Microfiche	
Diskettes	Microfilm	
Tape	CRT	
Disk		

EXPOSURE POINTS

FIGURE 4

Physical Loss - Fire, Water, Radiation, Theft, Explosion, Machine Error (e.g., card damage), Malicious Damage, Erasure, Transmission Error, WriteOver, Mismark, Mislaid

Compromised Data - Theft, Copy, Alter, Misleading Data, Careless Disclosure, Deliberate Disclosure, Extraction of Data, Electronic Eavesdrop

RISK IN DATA PROCESSING ENVIRONMENT

FIGURE 5

UNIVERSITY OF ILLINOIS
PRIVACY AND SECURITY STUDY

TYPE OF DATA INDIVIDUAL STUDENT	*From the point of view of your position in the University, how critical would it be to the functioning of the University if each of the following types of data were lost?*	*In your opinion, how valuable would the following types of data be to a person who might steal it?*	*In your opinion, what is the likelihood of someone using each of the following types of data for the purpose of fraud or embezzlement?*	*From the point of view of your position, which answer best describes the situation of the University if each of the following types of data were disclosed?*
Demographic - Directory	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4
Demographic - Other	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4
Academic Record	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4
Transfer Credit	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4
Admission Data	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4
Financial Aid Allocated	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4
Financial Resources	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4
Employment	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4
Graduate Appointments	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4
Loans	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4
Accounts Receivable	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4
Fees Payable	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4
Housing Contracts	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4
Bad Checks	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4
Other Encumberances	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4
Other (specify)____________	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4
____________________	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4
____________________	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4
____________________	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4

KEY: *(Circle Preferred Answer)*

1 Not critical	1 No value	1 No likelihood at all	1 No embarrassment or loss
2 Not very critical	2 Little value	2 Not very likely	2 Embarrassment, no loss
3 Somewhat critical	3 Somewhat valuable	3 Somewhat likely	3 Embarrassment, some loss
4 Very critical	4 Very valuable	4 Very likely	4 Definite legal/financial loss

NAME____________________

DATE____________________

FIGURE 6

SOFTWARE & HARDWARE

- PROCEDURES
- PROGRAM CONTROL
- FAILURE (BACKUP, RESTART)
- STORAGE (RECORDS, PROGRAMS)
- ACCESS CONTROL (PASSWORD)
- PHYSICAL DETERRENTS
- PROCESSING
- TELECOMMUNICATIONS
- QUALITY CONTROL
- ACCURACY CONTROL

PEOPLE

- POLICY & PROCEDURES
- FRAUD
- EMBEZZLEMENT
- PHYSICAL DETERRENTS
- PERSONNEL CHECKS
- TRAINING
- DOCUMENT CONTROL
- AUDIT
- ADMINISTRATIVE CONTROLS

CONTROL TOPICS

FIGURE 7

PRODUCTIVITY AIDS AND PROJECT MANAGEMENT IN AN IMS SYSTEM DEVELOPMENT EFFORT

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This paper discusses the results of the application of several productivity aids and project management control techniques to a completed transaction-driven system composed of 59 Purchasing Bid Processing and Vendor-Commodity data base maintenance programs. The methodology of top-down modular design implementation with a chief programmer team organization are discussed followed by presentation of actual experiences with a PERT chart based project control technique, HIPO program documentation, program design language, structured programming, structured walkthroughs, and test planning in a complex testing environment.

PRODUCTIVITY AIDS AND PROJECT MANAGEMENT IN AN IMS SYSTEM DEVELOPMENT EFFORT

Introduction

The major objective of Part 1 of this paper is to describe a project planning and control technique. However, the success of the project for which the planning and control technique was applied cannot be attributed singularly to adequate project planning and control. Part 2 of this paper describes the use of several improved productivity techniques during the implementation phase of the project. These techniques improved intra-team communications and thereby improved project managability as well as productivity. The success of a project and a system depends upon effective procedures in all phases of development. Therefore, the system definition and system design phases will be briefly discussed as an introduction to the Programming and testing phases where project planning and control are most appropriate.

PART 1

Definition Phase

Numerous management information oriented projects fail because of a poorly defined scope. The data gathering and team study that is performed is typically limited to a process or a sub-process where a great information need exists. The resulting definition does not describe the interrelationships to processes and data that are peripheral to the major source of aggravation.

The top down system or process analysis approach recommended as Business System Planning[1] methodology is suggested as the first step toward successful IMS based management information systems. The BSP study provides a systems implementation plan that addresses the objectives of top management in addition to identifying the interrelationships and information needs that cross organizational lines.

The following description assumes that a subsystem to support the process of interest has been chosen based upon a logical implementation sequence: A bottom-up implementation sequence is suggested once the top down analysis has been completed.

A more detailed data gathering activity is usually necessary following the definition phase of a BSP study. A functional specification form is suggested as a guide to insure thorough data gathering. Figure 1 depicts a suggested format that will provide data for both data base and system design activities. The purpose is to conceptualize and to specify automated functions that interface and support user office procedures within the process that is to be supported. The originality and imagination of the designer is useful during this conceptualization. Reviews by the customer being supported should result in additions, deletions, and changes to the original functional specifications.

SYSTEM SPECIFICATION

FIGURE 1

FUNCTION DESCRIPTION SHEET

MAJOR SYSTEM ID:____________ TEAM MEMBER____________

FUNCTION NO.________________ DATE__________ PAGE_________

1. Service or Function Name:

2. Function Description:

3. Frequency:

4. Data Elements Required:

5. Availability Requirements [Response Time or Turnaround Time] :

6. Major Function Group and Related Functions by Number [Describe Interfaces]:

7. Logical View:

Once a functional specification package is completed and approved to include interfaces to existing and future systems, the user office and system procedures should be documented using HIPO techniques to assure that the envisioned system functions provide adequate closed loop information feedback support. The HIPO documentation should also be approved by the customers involved. Walk-through presentations will enhance the approval process. A list of required data elements should also be created from the functional specification forms. The list should include format, length, and descriptive information. This list, with general groupings by source, should be reviewed for completeness and accuracy by the customers involved and by the design teams. Various data base service analysis systems are available to allow such data element information to be keyed and stored. The use of such a system will save considerable grief during the next phase of the project.

System Design Phase

Data base and system design procedures cannot be covered adequately in this paper. However, a few comments will be made to maintain the continuity of the paper.

The beginning of the system design phase is an appropriate time to increase the size and talent of the project team. The nature of project activities becomes more internal once the data is gathered and approved. Senior programmer talent is appropriate to debate design strategies during team brainstorm sessions. Once the nature of all of the system functions is reviewed and understood by the design team, a general system concept is needed to organize the system around. A transaction driven concept works well with IMS since it is simply an extension of the operational nature of IMS.

If a transaction driven approach is chosen, the top or the controllers of the system should be defined logically. A typical controller make-up is given as one approach: on-line menus, batch update controller, and batch report writer controller. A division by frequency of processing might be more appropriate if the system has divergent processing frequency requirements.

Once the controllers are chosen and defined, the system design is simply a process of organizing the program modules within homogeneous controller actions. This involves a repeat of the analysis of the types of transactions that drive the controllers.

The complicating factor during this phase of the project is that neither the data base nor the system design is complete. This is viewed by the author as an iterative process. As the functions are defined in more detail, the logical views change, requiring a re-design of the logical data bases. Reviews of all functions that are affected by the re-design of the logical data base influence the operation of those affected program modules as well as causing further data base revisions. This procedure is continued until all requirements are met. Comprehensive data gathering will preclude more problems during this activity than will any other factor. The objective is to minimize surprise.

Detailed program design can be postponed until the full implementation team is assigned. The system design proposal that reflects the above analysis, along with function description sheets, I/O definitions, and data base definition will serve as input to this activity. A detailed system walkthrough with the implementation team will 'kick off' the detailed program design task appropriately.

Programming and Implementation Phase - A Project Planning and Control Technique

The project control system that is described here by example is based upon a master composite representation of the system (RAP chart) and upon three different ways of looking at the status of the project:

1. by team member (The Team Member Benchmark Reports - Figure 3 and 3A)

2. by date (The Master Calendar - Figure 4)
3. by program (The Program STATUS Log - Figure 5)

The generation of the RAP chart is by far the most difficult and the most critical task that must be performed. The project manager must have a thorough understanding of the system design and of the numerous task interdependencies associated with the installation of a system as a prerequisite to the development of the "RAP" chart. Notice that the use of this system assumes the completion of a system design and a system design proposal, estimates in man days of program code and compile test time requirements, and predetermined development team resources to include an a priori FTE usage plan for each team member. This allows simultaneous program assignment and project planning using the RAP chart.

Resource Assignment and Planning (RAP) Chart - Figure 2

This charting method gets its name because each team member is given a horizontal planning line on the chart that reflects task assignments. This technique has 'pert merit' since it is obvious that one team member cannot complete all of his assigned tasks simultaneously. That is, the member is time/task critical pathed. This technique causes an increase in the number of required null paths and task crossings on the chart (dotted lines with activity codes beginning with X, Y, or Z, e.g.XA, YB, ZC).

Programs are listed in order of their critical nature due to testing and installation dependencies so that critical programs will be assigned to different team members to achieve an earlier completion of all critical programs. Similar programs or programs with a similar function are grouped to one team member to allow learning and coding reduction benefits.

Programs are assigned tip to tail along the team members' horizontal axis in priority order within groups or clusters. A twenty percent overlap is planned in figuring the time consumption for each task. Note that an attempt is made to keep each team member equal datewise. The length of the arrows are to scale datawise in weeks such that a vertical line drawn through the chart would give a planned project status at any point in time.

Activities that require the participation of several team members are kept in the central horizontal axis of the chart, or, when impossible due to graphical difficulties, are inserted between two different team member activity lines. Group activities typically have several incoming arrows to their begin task nodes and have several outgoing arrows from their ending nodes. Such activities can be expected to be on the critical path. At least they are critical projectwise. These group tasks can be used as team benchmarks for control during the project.

Standard pert chart node number assignments must be made, i.e., ascending numbers from left to right. The assignment of these numbers is not critical. In fact, the numbers can be assigned after the chart is completed.

In some cases, two or more tasks must be performed simultaneously by one team member. In such cases, the most critical task should be placed on the member's horizontal axis while the other task(s) are branched to and are returned from. A return from a group activity is shown with numerous null paths returning to multiple team member axes.

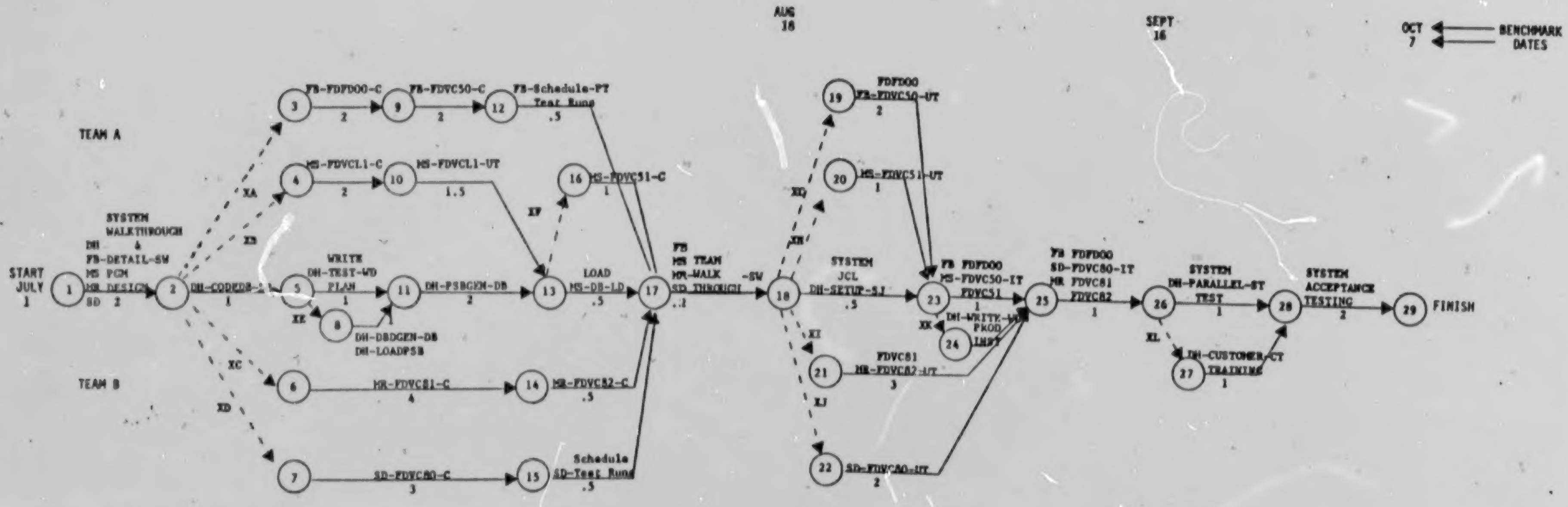
Consider the legend on the attached RAP Chart while reviewing the RAP example. Each task is so coded for cross reference to other reports.

The number shown beneath the arrow on the RAP Chart is the time requirement in weeks or in portions of weeks. Data notes and other notes are shown at the top and bottom of the RAP.

The Team Member Benchmark Report - Figure 3

The team member benchmark report can be written directly from the RAP chart by following a horizontal axis for a team member and by completing the cover sheet that is attached. The only additional effort required is to determine the required completion date for each task. A 20% overlap of tasks can be figured for some tasks.

FIGURE 2 - RAP CHART EXAMPLE


AUG
18
SEPT
16
OCT
7
BENCHMARK
DATES
TEAM A
TEAM B
START
JULY
1
SYSTEM
WALKTHROUGH
&
DH
FB-DETAIL-SW
MS PGM
MR DESIGN
SD 2
DH-CODEDB-1
1
FB-FDFDOO-C
2
FB-FDVC50-C
2
FB-Schedule-PT
Test Runs
.5
MS-FDVCL1-C
2
MS-FDVCL1-UT
1.5
XA
XB
XC
XD
XE
XF
WRITE
DH-TEST-WD
PLAN
1
DH-DBDGEN-DB
DH-LOADPSB
DH-PSBGEN-DB
2
MS-FDVC51-C
1
LOAD
MS-DB-LD
.5
MR-FDVC81-C
4
MR-FDVC82-C
.5
SD-FDVC80-C
3
Schedule
SD-Test Runs
.5
FB
MS TEAM
MR-WALK
SD THROUGH
.1
-SW
FDFDOO
FB-FDVC50-UT
2
MS-FDVC51-UT
1
XG
XH
XI
XJ
XK
XL
SYSTEM
JCL
DH-SETUP-SJ
.5
FB FDFDOO
MS-FDVC50-IT
FDVC51
1
DH-WRITE-WD
PROD
INST
FDVC81
MR-FDVC82-UT
3
SD-FDVC80-UT
2
FB FDFDOO
SD-FDVC80-IT
MR FDVC81
FDVC82
1
SYSTEM
DH-PARALLEL-ST
TEST
1
DH-CUSTOMER-CT
TRAINING
1
SYSTEM
ACCEPTANCE
TESTING
2
FINISH
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29

LEGEND

Program Number
or Abbreviated
Task Description

FB-FDFDOO-C

Initials
of [illegible]
[illegible]

ACTIVITY TYPE CODE

C-Code and Compile Test Program
UT-Unit Test or Simulation Test Pgm
IT-Integration Test Program
WD-Write Documentation
SW-Structured Walkthrough
LD-Load Data
PT-Plan Tests
DB-Data Base De'n or Gen

EXAMPLE EXTRACTED FROM
RAP CHART FOR 59 PROGRAM
SYSTEM.

That is, coding will begin on the following program after the current program is between 50% and 80% coded. The effective overlap is estimated at 20% on the coding and compile testing activities.

The calendar set (Figure 3A) is included mainly to allow the indication of actual completion relative to assigned or estimated completion. This report serves the following purposes by giving a copy to the team member as well as maintaining a set for the project manager:

1. Serves as media for program assignment.
2. Is used for individual planning by the team members.
3. Serves as recording mechanism for recording task completion problems by individual.
4. Provides an access to project status by individual.

Note that the IBM calendar is used and that a page is kept for each month of the project implementation life and for each team member. Red ink notation can be used on the calendar when tasks are significantly behind. Additional notes can be made to the calendars, e.g., team member was sick for three days, additional tasks were performed, program was re-assigned to another team member, keypunch was lost, team member will catch-up because of the termination of front end loading, etc.

A set of these forms is filed in the project file by team member name.

TASK ASSIGNMENT AND BENCHMARK REPORT MEL RUSH

[Critical Path Team Member] FIGURE 3

PROGRAM NO.	TASK DESCRIPTION	RAP CODE	RAP NODES	COMPL. DATE
———	Detail Design PGM 81 & 82	Detail Team- PGM Design	1,2	7-14
PGFDVC81	Code and Compile Test 81	MR-FDVC81-C	6,14	8-11
PGFDVC82	Code and Compile Test 82	MR-FDVC82-C	14,17	8-17
———	Pre-Unit Test Team Walk-through	Team Team-Walk-SW through	17,18	8-18
PGFDVC81,82	Unit Test Programs 81,82	FDVC81 MR- -UT FDVC82	21,25	9-8
———	Integration Test Report Module	FDFD00 Team-FDVC80-IT FDVC81 FDVC82	25,26	9-14

International
Business
Machines
Corporation

IBM

TASK ASSIGNMENT AND BENCHMARK REPORT

[Critical Path Team Member]

MEL RUSH

FIGURE 3A

S	M	T	W	T	F	S
1 214	2 215	3 216	4 217	5 218	6 219	7 220
8 221	9 222	10 223	11 224 PGFDVC81 Coded and Compile Tested	12 225	13 226	14 227
15 228	16 229	17 230 PGFDVC82 Coded and Compile Tested	18 231 Pre-Unit Test Walk-through Completed	19 232	20 233	21 234
22 235	23 236	24 237	25 238	26 239	27 240	28 241
29 242	30 243	31 244				

July

S	M	T	W	T	F	S
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31

September

S	M	T	W	T	F	S
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30		

August 1976

421

422

421

The Master Calendar - Figure 4

The master calendar is the main control feature of the entire project control system. It can be viewed as a 'Total project GANTT' in that it shows the required completion date of all tasks. The master is simply filled out by using all team member benchmark reports for each month in the project life, one month at a time. Transcription from one to the other is performed by using the following coding scheme:

81 ⑭ MR

Last 2 digits of program number ↗ ↖ending RAP node ← team members initials

A red circle around the encoded task designated tasks that are significantly behind. A checkmark designates a completed task (whether it has been previously encircled or not).

The current, previous, and next months master calendar and the RAP can be kept in view for easy access by the project manager. All other reports are filed by their key or by their function.

The Program Status Log - Figure 5

The program status log is organized by program number within module. It is updated weekly as are all other reports. The use of the log is self-explanatory with two exceptions:

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EXAMPLE SUBSYSTEM

MASTER CALENDAR

FIGURE 4

S	M	T	W	T	F	S
1 214	2 215	3 216	4 217 80 ⑮ SD	5 218	6 219	7 220
8 221	9 222	10 223 50 ⑫ FB PSBGEN ⑬ DH L1 ⑬ MS	11 224 81 ⑭ MR	12 225	13 226	14 227
15 228	16 229	17 230 82 ⑰ MR 51 ⑰ MS Schedule Test ⑰ SD Schedule Test ⑰ FB	18 231 ALL ⑱ ALL	19 232	20 233	21 234
22 235	23 236	24 237	25 238	26 239	27 240	28 241
29 242	30 243	31 244				

July

S	M	T	W	T	F	S
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31

September

S	M	T	W	T	F	S
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30		

August 1976

1. Numerous blank areas in the various status categories when compared to other modules reflect a need to look more closely at the program development status for the module.
2. (***)Programs coded in this manner are subject to re-assignment unless improvement in status is predicted for one reason or another.

Cross references are possible from the program status log to the RAP or to the team member benchmark report. The master calendar can easily be cross-referenced to this report using the last two digits of the program number.

The Project Report Form - Figure 6

The project report form is filled out by each individual team member. The report is the mechanism for a weekly update to all previously described reports. The report form is submitted on Friday. All updates are performed by the project manager on Monday. Occasional reviews can be held with team members if progress problems cannot be reconciled easily.

A significant deviation from the plan does not necessarily require an action. Various notes can be made to study the problem again at a later date. The main purpose is to notice and to discuss the potential problem before it becomes a critical problem that will preclude the timely completion of a benchmark task.

The total weekly hours on the report form serve an

FIGURE 5

PROGRAM STATUS LOG (Status Shown As Of August 20) July 1, 1976

PROGRAM NAME	PGMMR	HIPO/ WRITE-UP	PDL	ALL CODED	ALL COMPILE-TESTED	UNIT OR BTS TESTED	ON-LINE TESTED	INTEGRATION TESTED	START DATE	ASSIGNMENT ORDER	SIGN-OFF DATE	NOTES
Batch Update Module												
1. PGFDFD00 Financial Controller	FB	July 14	July 14	July 20	July 23	Aug 20	N/A		Jul 15	FB1		
2. PGFDVC50 Batch Update Controller	FB	July 14	July 14	Aug 2	Aug 6		N/A		Jul 20	FB2		
3. PGFDVC51 Vendor Update	MS	July 14	July 14	Aug 13	Aug 17		N/A		Jul 27	MS2		
4. PGFDVCL1 Load Vendor DB	MS	July 14	July 14	July 27	July 29	Aug 12	N/A		Jul 15	MS1		
Batch Report Writer Module												
5. PGFDVC81 Batch Report Controller	SD	July 14	July 14	July 20	Aug 4		N/A		Jul 15	SD1		
6. PGFDVC83 Commodity Cross Index List	MR	July 14	July 14	Aug 2	Aug 12		N/A		Jul 15	MR1		
7. PGFDVC82 Vendor Alpha List	MR	July 14	July 14	Aug 16	Aug 18		N/A		Aug 2	MR2		

accounting purpose. The completed forms will be accumulated in a file until the end of the project. The man-day requirement for each program and for other time associated with the project can then be tabulated by function within program for project review purposes.

NAME Mel Rush

WEEK ENDING August 13, 1976

PROJECT
REPORT
FORM

FIGURE 6

PROGRAM NUMBER/OTHER TIME	OT-Project OT-Other	TOTAL MAN HOURS/	END OF WEEK PGM STATUS
PGFDVC81		20	/Clean Compile
Commodity Cross Index List			
PGFDVC82		15	/Coding 3/4 Complete
Vendor Alpha List			
Other Time - Project			
Created test transactions		3	
Sick Leave Monday		4	

PART 2

General Comments

The dictionary defines productivity as the quality or state which furnishes benefits, results or profits. The need for benefits and results from computer-based systems is the reason that program productivity is a popular topic of discussion in data processing today. The high costs incurred in system development and maintenance demand that we attempt to be as cost-effective as possible. We need efficiency, quality and quantity in our programming tasks. We have deadlines to meet; systems must be completed by the agreed-upon target dates. As dates are missed, the service organization loses credibility. With the high cost involved in salaries, management would like to get as much output as possible. At the same time, we would like systems to be as error-free as possible. Maintenance is a burden to most data processing offices--traditional programs with "bugs" buried in "spaghetti bowl" code have left many analyst/programmers with strong negative feelings about maintenance work. Finally, to get the most from our sophisticated hardware, we want efficient programming.

Productivity in programming is not a cure-all. In fact, it isn't anything new. The basis underlying productivity is discipline, mostly self-discipline. In any task we undertake, we usually learn how important it is to be organized, to know exactly what we are going to do, to have ready all we need to do it, and to follow a straight-forward path from start to finish. When we do any of these things in an incomplete manner or try to find a short-cut, we pay the cost in incomplete results which often require repairs.

Management sees productivity as an aid to higher quality and quantity in output. It is important to realize that it can also be an aid to increased motivation from the subordinates. If productivity is accepted into the office's work procedures with positive attitudes, the employees can find their own set of benefits in improved skills, a gain in self-confidence, and a sense of challenge. Training is always a major cost concern. Formal training costs time and money, but lack of it has a snowball effect in lowering the average capability of employees over a period of time. Carefully chosen programmer teams can, with the use of productivity tools, become valuable training aids as a side benefit. Programmers traditionally learn from those around them in informal discussion. The structure of productivity approaches adds the organized and disciplined attributes of formalized training to this informal training tool. The self-confidence mentioned as an employee benefit is the confidence a programmer can gain in feeling that his programs are mostly error-free, easy to read, and highly maintainable. This aids what is called "egoless" programming. If a programmer feels his product is good, he is less likely to feel insecure or threatened in submitting that program to his peers and superiors for scrutiny. We all have the need to take pride in what we do. Finally, there is a sense of challenge. Often programmers reach a level of capability and become bored, due to a lack of more demanding work. Maintenance programmers become disillusioned with fixing systems that never become totally fixed. Productivity offers the challenge of a real possibility of almost error-free coding, which means a drastic drop in debugging after the system is up. Repair work becomes a more constructive task, rather than the destructive job it has been, where one fix creates more bugs.

To get good results from program productivity aids, it is important to consider the attitude of management and subordinates. The productivity tools and the rules for using them are straightforward. But they will be useless or worse than useless if implemented with the wrong attitude. Management should:

1. Be enthusiastic
2. Realize that actual coding output is now to be purposely delayed until proper program designs are made
3. Realize the increased need for a formal discussion area for team meetings
4. Realize that there will be reluctance from some programmers to participate--this is a major factor requiring real tact. Experienced programmers should be shown that most productivity aids come from habits developed by good programmers

5. Have productivity aids introduced enthusiastically by subordinates' peers if possible with strong visible support of management.
6. Structure program teams with mixture of strong and weak capabilities
7. Require teams to establish written guidelines before beginning development
8. Require periodic (i.e., after a project is completed) reviews of guidelines and suggestions about revised use of productivity aids. Experience will redefine the proper use of these aids
9. Realize that program productivity requires a well-structured and complete system design

Chief Programmer Teams

We implemented a modified use of the chief programmer concept. Our teams consisted of a chief programmer and three other programmers. Each team was given development responsibility for a specified set of programs. (Overall review was done by the project leader.) The team leader was responsible for assigning programs and ensuring proper review stops were accomplished. Most of the librarian functions were handled by each member of the team. The chief programmer handled the coordination librarian functions. Each member of a team was expected to develop a good understanding of the programs developed within his team. Chief programmers of various teams were expected to ensure necessary interaction between the teams for overlapping tasks and were expected to coordinate integration testing with the project leader and with each other.

Productivity Aids Used

Our project group developed our first IMS-based system using the following productivity aids:

- HIPO program documentation
- Program design langauge
- Structured coding
- Structured walkthroughs
- Test planning in a complex testing environment

We used each of these tools and strongly recommend that the last three be required tools and the first two be suggested tools.

HIPO Program documentation

HIPO is the structured documentation technique using hierarchy overview charts and input-process-output detail worksheets. From brief program narratives we prepared HIPO charts and worksheets for each program. These were filed as program documentation. (The system proposal included HIPOs for the system design--but not to the program detail level.) Whether the programmer uses HIPO or some other design tool, the important thing is that the programmer designs the structure of the program without doing any actual coding. The basic rules for HIPO are simple--the difficulty is in application. Review of a complete sample and and experimentation is the best means for learning. We did establish some guidelines which merely stated basic rules for the use of HIPO, and provided the IBM manual on HIPO for reference. (See Figure 7A and 7B for sample pages of a program HIPO hierarchy chart and worksheet.)

Program Design Language

Once a programmer established the structure of the program and before he started coding, we recommended the use of Program Design Language (PDL). PDL is a type of shorthand for programming languages which assumes structured coding concepts. It can be considered an alternative to detailed flowcharts. There are four basic statements in PDL: function, invoke, if then, and do while. Function is a simple statement describing an operation to be done (not how). For instance:

```
Calculate gross pay.
```

The invoke statement is equivalent to the PERFORM paragraph A in COBOL. For instance:

```
INVOKE edit transactions routine (see page xx of PDL)
```

The 'if then' is one of the most frequently used statements in structured programming. PDL requires complete statement for the 'if then.' For example:

```
IF the employee is academic
THEN write record on selected file
ELSE bypass record
ENDIF
```

FIGURE 7A

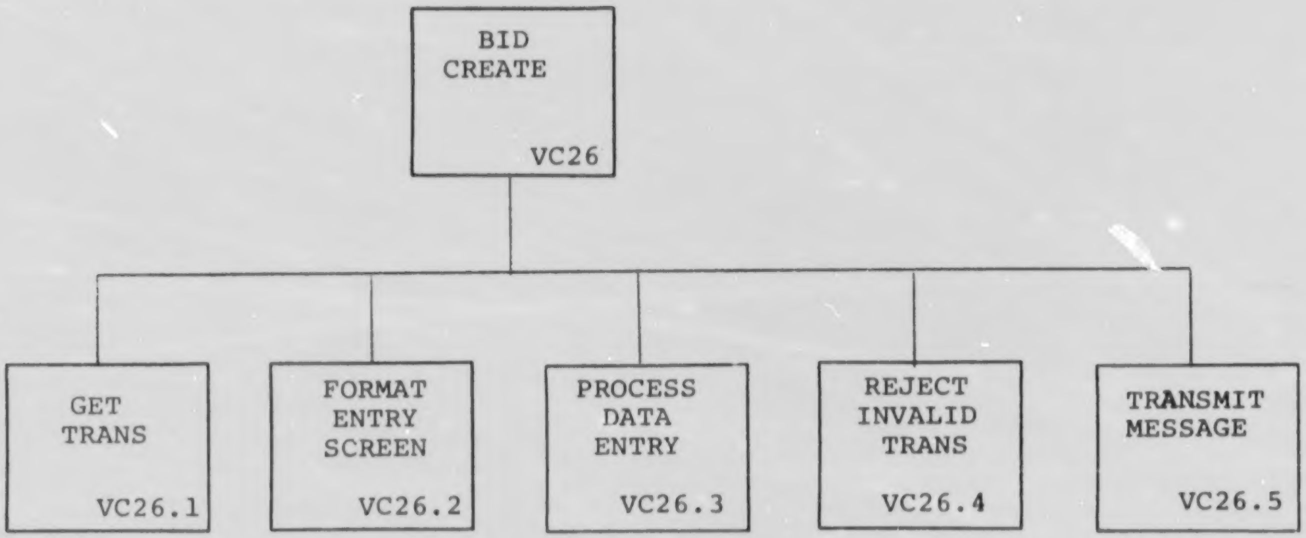
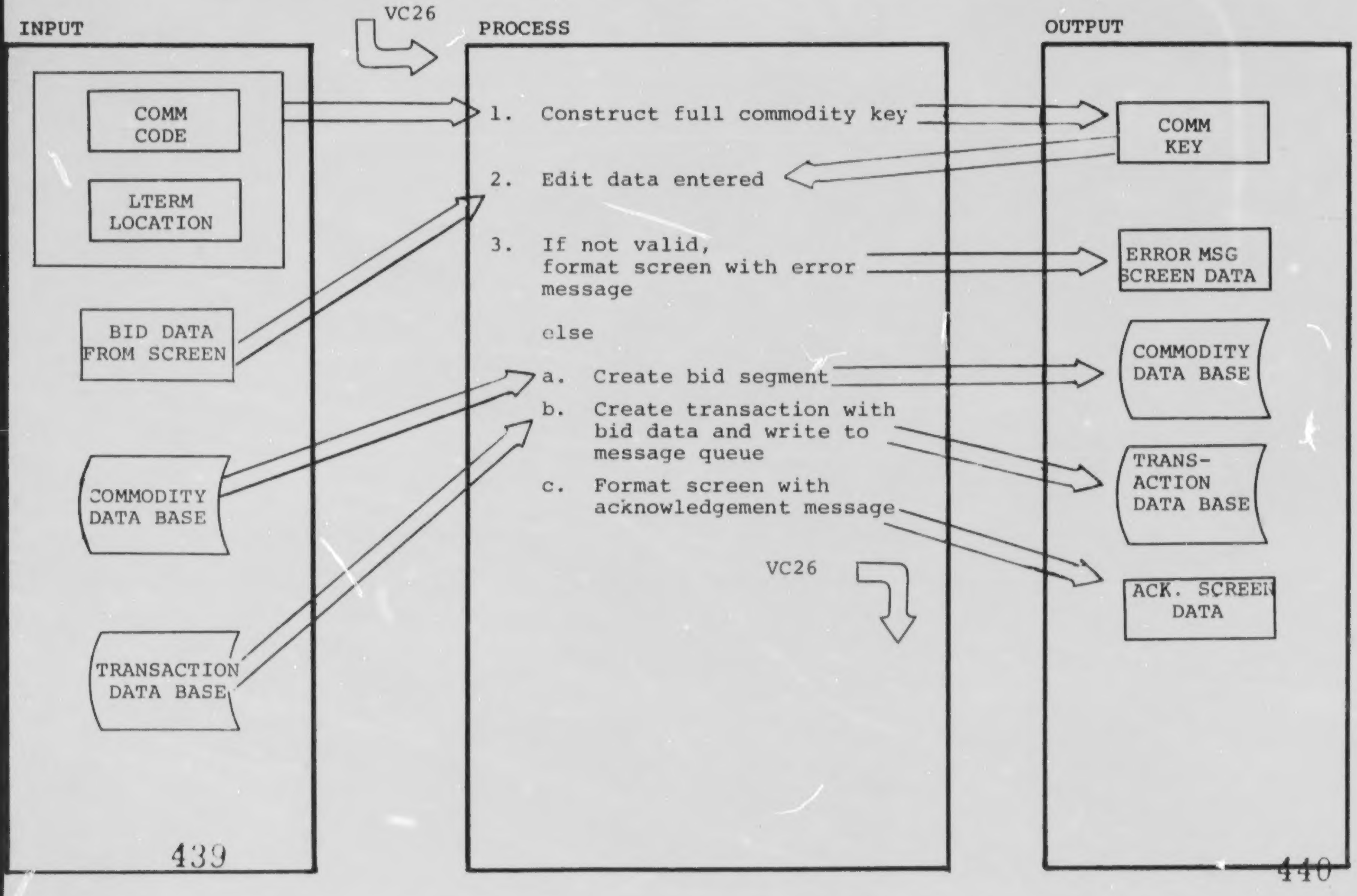

BID
CREATE
VC26
GET
TRANS
VC26.1
FORMAT
ENTRY
SCREEN
VC26.2
PROCESS
DATA
ENTRY
VC26.3
REJECT
INVALID
TRANS
VC26.4
TRANSMIT
MESSAGE
VC26.5

Figure 7B

SYSTEM ID: ______ **DIAGRAM ID:** VC26.3 **PAGE:** ______

DESCRIPTION: ______ **DATE:** ______



1. Construct full commodity key
2. Edit data entered
3. If not valid, format screen with error message

   else

   a. Create bid segment
   b. Create transaction with bid data and write to message queue
   c. Format screen with acknowledgement message

INPUT
VC26
PROCESS
OUTPUT
COMM CODE
LTERM LOCATION
BID DATA FROM SCREEN
COMMODITY DATA BASE
TRANSACTION DATA BASE
COMM KEY
ERROR MSG SCREEN DATA
COMMODITY DATA BASE
TRANS-ACTION DATA BASE
ACK. SCREEN DATA
VC26
439
440

(the ENDIF signifies the end of the 'if' statement and especially helps to clarify the end of embedded 'if' statements).

The 'do while' is equivalent to the PERFORM UNTIL in COBOL. For example:

```
DOWHILE  location is Urbana
INVOKE check employee type (see page xxx)
ENDDO
```

(The ENDDO signifies the end of the 'do while' statement.)

Although PDL often resembles program code, the programmer must avoid writing in code. PDL allows the programmer to completely think out his program logic statements before coding. This saves valuable time which is often lost in rewriting portions of code.

The guidelines for PDL included definitions for the above four statements plus rules for uniformity such as indentation.

See Figure 8 for a partial PDL sample. Our group did not save our PDLs, but merely used them for the step between the HIPOs and actual code.

Structured Coding

Since there are numerous articles and books on structured code, we will not discuss the how to of coding. We do recommend establishing written guidelines. If well-written, the guidelines become a useful reference manual. For our first formal use of

Figure 8

PDL example:

```
(1st level)
      initialize
      READ master
      READ transaction
      DOWHILE more master and more transaction records
              DOWHILE master key < transaction key
                     WRITE master
                     READ master
              ENDDO
              DOWHILE master key = transaction key
                     INVOKE update master routine
                     READ transaction
              ENDDO
              DOWHILE master key > transaction key
                     WRITE 'no master for transaction' error message
                     READ transaction
              ENDDO
      ENDDO
      DOWHILE more master records
              WRITE master
              READ master
      ENDDO
      DOWHILE more transaction records
              WRITE 'no master for transaction' error message
              READ transaction
      ENDDO
      terminate the program
```

(2nd level)

```
Update Master Routine

IF transaction code = 'U'
THEN
        IF transaction data valid
        THEN
               update master record
        ELSE
               WRITE 'invalid transaction data' error message
ELSE
        IF transaction code = 'D'
        THEN
               delete master record
        ELSE
               IF transaction code = 'A'
               THEN
                    format master record.
```

structured code, we allowed absolutely no GO TO statements. We felt this would force structured coding thinking. We feel this rule had value in requiring us to really think about our program structure. The first program without a GO TO is a bit of a struggle for most programmers. (PDL was invaluable here.) After several programs, we felt that it is more efficient to allow the GO TO in the limited boundaries of the case statement (see Figure 9A). The indentation rules (see Figure 9B) for the IF, THEN, ELSE combination show their value whenever the program is read. Ease in readability must be a major concern when coding. The small amount of effort required to ensure readability is more than offset by the savings in time required for others to read and understand the program.

Structured Walk-throughs

In my opinion, the structured walk-throughs may be the most powerful productivity tool. The walk-through is a formalized review of a phase of a project to ensure accuracy and completeness. It is extremely important that the atmosphere be positive. A meeting time and place are established; the session must be kept to no more than 2 hours; there may be from 2 to 6 attendees (3 or 4 is the most effective number); total information on the item to be reviewed must be distributed before the meeting with plenty of time allotted for the attendees to prepare for the session. During the session, one person should

Figure 9A

STRUCTURED CODING STANDARDS (excerpts)

Case structure -

GO TOs must always branch forward to exit paragraph, requires the use of PERFORM . . . THRU . . .

```
Example:
    PERFORM Paragraph A THRU Paragraph Z.

Paragraph-A.
    GO TO  Paragraph-A-1
           Paragraph-A-2
               ...
           Paragraph-A-n
        DEPENDING ON integer-identifier.
    error routine.
Paragraph-A-1.
      ...
    GO TO  Paragraph-Z.
Paragraph-A-2.
      ...
    GO TO Paragraph-Z.
.
.
.
Paragraph-A-n.
      ...
    GO TO Paragraph-Z.
Paragraph-Z.
    EXIT.
```

Figure 9B

STRUCTURED CODING STANDARDS (excerpts)

1. IF, THEN, ELSE
   - always align the set in same columns
   - code THEN and ELSE on single lines
   - indent action statements from THEN or ELSE
   - limit nested IFs to 5 levels

   [For example, see Figure 8 - rule also used for PDL]

2. PERFORM paragraph A-THRU paragraph-B
   - no intervening paragraphs
   - GO TOs allowed only in paragraph-A
   - GO TOs must go to paragraph-B

   [Only legal use of GO TO outside case-structure]

3. Limit segment to 2 pages

4. Use COBOL skip verb for readability

record all errors detected. At the end of the 2 hours, the group should decide whether the walk-through is complete or needs to be rescheduled or whether the program requires another walk-through as soon as the errors detected are corrected. Each completed walk-through should be recorded as a step in the program's development.

During our project, we held walk-throughs for a general review of all program specifications and for each program after it had a clean compile. Walk-throughs can also be useful at the program design stage (to spot structure or logic errors before coding), and during the test planning and debugging stages.

Walk-throughs provide a means for detecting errors early in program (and system) development. The participants develop a repertoire of most frequent programming errors and more importantly, share the other attendees' programming knowledge. Reading code is considered one of the best means for improving one's own code. The walk-through furnishes incentive for reading code carefully and thoughtfully. Obviously, ease of program readibility is a requirement for effective walk-throughs. As the programmer watches error detection process, he becomes more committed to make the same effort in reading the programs of others as he wants for his own. The walk-through provides the environment for learning of new techniques and building of group cohesion as well as familiarity with the group's programs.

Programs become more consistent within a system as each attendee conforms more to the group's developing ideal.

Attitude is critical to the walk-through. Attendees must avoid personal attacks or accusations. Errors are to be detected, not necessarily solved. Practicality must be considered; rewrites are not always possible or reasonable. Each walk-through requires a moderator to exercise tact, prevent digression, help prevent nit-picking, and provide direction.

Test Planning

Lastly, but certainly not least, is the use of a structured approach to testing. Once a program reached the compile stage, the programmer should be required to prepare a test matrix for testing. The matrix should reflect the different possibilities of input and the expected results. For single program testing the programmer is expected to prepare his own test data (or a team may work together to prepare common test data). As the program is tuned to an expected result, this is checked on the test matrix. Often it is either humanly impossible or impractical to test all conditions. The team should review the test plan in a walk-through and determine the minimum required testing. Normally an attempt is made to at least test each line of code.

Once the test is completed, the plan and test data are stored. Future revisions or corrections should require complete retesting to ensure program and system integrity. We have found these files to be indispensible and real time-saving devices.

Of course, after single program testing, there must be full integration system tests. At this stage, the project leader, along with the back-up of the chief programmers of each team, specifies in written form the conditions and actual data required for integration testing, and conducts the review of the system test results. See Figure 10A and 10B for examples.

Conclusion

One of the common traits in the productivity tools is the team approach, whose benefits include improved system development, increased technical ability throughout the project group, back-up for system familiarity, and hopefully an increased enthusiasm for self-improvement.

VC04												TRANSACTIONS									FIGURE 10A			
FIELDS		FROM MENU OR PF KEY										FROM VC03				FROM ENTER KEY								
1. Commodity Code	N/A	I	V_1	V_1	V_1	V_1	V_2	V_3	V_3	V_3	V_1	V_3	V_3	V_3	V_3	I	V_1	V_1	V_2	V_1	V_3	V_3	V_3	V_3
2. Bid Number a. buyer code		V_1	I	V_1	V_1	V_1	V_1	V_2	V_3	V_3	V_1	V_3	V_3	V_1	V_1	V_1	I	V_1	V_1	V_1	V_2	V_3	V_3	V_3
b. seq num		V_1	V_1	I	V_1	V_1	V_1	V_2	V_3	V_3	V_1	V_3	V_3	I	V_1	V_1	V_1	I	V_1	V_1	V_2	V_3	V_3	V_3
c. sub code		V_1	V_1	V_1	I	V_1	V_1	V_2	V_3	V_3	V_1	V_3	V_3	V_1	V_1	V_1	V_1	V_1	V_1	V_1	V_2	V_3	V_3	V_3
3. Bid Proposal Date		V_1	V_1	V_1	V_1	I	V_1	V_2	V_3	V_3	V_1	V_3	V_3	V_1	I	V_1	V_1	V_1	V_1	V_1	V_2	V_3	V_3	V_3
4. Alt Campus		V_2	V_2			V_2				V_1 V_2	I	N/A				N/A			N/A					V_2
5. Hidden Vendor		N/A									→	N/A			→	ERRK			ERRN	ERRC	ERRB	NONE	NO MORE	VEND #
6. Hidden PO		N/A									→	N/A			→	NONE			NONE					NONE
7. Page Number		N/A									→	N/A			→	P	P	P	P				→	P
(Expected Results)																								
Message		18	23	23	23	12	01	03	92	91/90	81	91	90	23	12	34	34	34	01	81	03	90	91	91
Hidden Vendor (out)		ERRK	ERRK	ERRK	ERRC	ERRK	ERRN	ERRB	NONE VEND #	NO MORE NONE	ERRC	NO MORE	NONE	ERRK	ERRK	ERRK			ERRN	ERRC	ERRB	NONE	NO MORE	NO MORE
Hidden PO (out)		NONE	NONE	NONE	NONE	NONE	NONE	NONE	PO# NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE								NONE
'Last' Page Literal		b̸						>	b̸	LAST	b̸	LAST	LAST	b̸	b̸	b̸							→	LAST
TEST RUN # AND DATE		6/24 5199							6/24 5199	6/24 5199	6/24 5196	6/24 5196	6/24 5196	ON-LINE	ON-LINE	6/24 5199		→	ON-LINE				→	6/24 5199

VC04

Figure 10B

'FROM OUTSIDE SYSTEM'

transaction code not matched to expected length or MOD name does not begin with 'MGFD'

1. Commodity:
    - I= not numeric, or zeroes
    - V_1= numeric and not zero
    - V_2= numeric and not zero, not in DB
    - V_3= numeric and not zero, in DB
2. Bid number:
    - a. buyer code
        - I= not alphabetic, or space
        - V_1= alphabetic and not space
        - V_2= alphabetic and not space, bid not in DB
        - V_3= alphabetic and not space, bid in DB
    - b. seq-number
        - I= not numeric
        - V_1= numeric
        - V_2= numeric, bid not in DB
        - V_3= numeric, bid in DB
    - c. sub code
        - I= not numeric or alphabetic
        - V_1= numeric or alphabetic
        - V_2= numeric or alphabetic, bid not in DB
        - V_3= numeric or alphabetic, bid in DB
3. Bid proposal date:
    - I= invalid date
    - V_1= valid date
    - V_2= valid date, bid not in DB
    - V_3= valid date, bid in DB
4. Alt campus:
    - I= invalid campus code
    - V_1= valid
    - V_2= blank

5. Hidden-vendor:

V_1= key error (ERRK)
V_2= commodity not in DB (ERRN)
V_3= bid not in DB (ERRB)
V_4= campus error (ERRC)
V_5= no response/PO data for bid (NONE)
V_6= no more response/PO data for bid (NO MORE)
V_7= next vendor value

6. Hidden-PO

V_1= no resp/PO data forbid (NONE)
or error condition
or no PO data (see hidden vendor)

V_2= next PO value

7. Page number:

P= present

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NETWORKING: EVOLUTION OF A COMPUTER NETWORK FOR HIGHER EDUCATION IN WEST VIRGINIA

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Director for Computing Services, West Virginia University;
Professor of Computer Science, West Virginia University;
Morgantown, West Virginia

The young West Virginia Network for Educational Telecomputing (WVNET), born March 4 1975, has survived its infancy and now shows signs of becoming a reasonably capable, responsible, and robust youngster. Attendant to its infancy were all the usual good intentions, hard work, fitful gasps, mother love, and "messy things which needed changing."

WVNET serves all fifteen of the State supported colleges and universities and is overseen by the West Virginia Board of Regents. Full service is provided for academic and administrative information processing needs. Remote site minicomputer-based terminals are served from a major "dual cpu" system hosted by West Virginia University.

This paper briefly reviews the purpose of, rationale for, and configuration of the network. Accomplishments and shortcomings are discussed.

Current efforts toward developing "common administrative applications systems" are discussed. Certain short range efforts, necessary for surviving the near-term period, appear also to hold promise for the longer haul ahead.

Finally, it is seen that some particularly attractive opportunities for "distributed" information processing exist. An examination is made of how one might go about turning opportunity into reality over the next several years.

OVERVIEW

The West Virginia Network for Educational Telecomputing (WVNET) was formed in March 1975 by the West Virginia Board of Regents. The Network is now configured with hardware and is a "going concern". WVNET serves all fifteen of the State supported colleges and universities. Service is provided for the full range of academic and administrative information processing needs. Remote site minicomputer-based batch terminals are served from a large host system located at West Virginia University in Morgantown.

BACKGROUND (AND HISTORY)

In The Beginning....

Interest in forming a computer network to serve higher education in West Virginia can be traced back to at least 1967. At that time, some twenty persons representing public and private colleges and universities within the state were actively participating in an ad hoc planning group, the "West Virginia Educational Computer Council".

During 1967-69, interest lay mainly in giving counsel to persons at West Virginia University who were then attempting to move the University out of the "7040 age" into more modern hardware. Considerable effort was given to attempting to spell out how one could meaningfully configure and use a network. Many good ideas were set forth.

In August 1969, West Virginia University purchased and installed an IBM 360/75 computer system.

In August 1970, the former "Council" was disbanded, and in its place, another planning group, the West Virginia Board of Regents "Computer Advisory Committee" was formed. Although the private schools were no longer officially represented, some planning efforts continued on that front. This Advisory Committee, supplemented by other personnel from the schools involved, met in December 1970 for further planning--this resulted in the first "State Plan for Computing for West Virginia Higher Education". This "State Plan" laid the framework whereby a network could be formed at a future date. It was apparent to a great number of persons that a network held promise, even though many persons felt considerable uneasiness in heading toward that direction.

Some Initial Hookups

In early 1972, remote service from the University's 360/75 was begun to a batch terminal located on the campus of West Virginia State College, at Institute West Virginia. This terminal served West Virginia State College, the West Virginia College for Graduate Studies, and the Board of Regents with their only computer service.

In July 1973, remote batch service was begun to Fairmont State College's IBM 1130 computer. In Summer 1974, remote batch service to Southern West Virginia Community College, West Virginia Northern Community College, and to Parkersburg Community College was begun.

All of these initial hookups were made solely because it made sense to do so! Participation in the evolving network at this stage was voluntary. No formal organization identified as a "network" yet existed, however.

FORMALLY CREATING THE NETWORK

Initial Effort

Efforts toward creating a network intensified in August 1974. A half-dozen persons, representing, initially, the Board of Regents, West Virginia University, and several existing remote users, plus an outside consultant, met often in Fall 1974 for planning and initial design. In February 1975, this effort culminated in a 118-page document, "A Plan for the Establishment of the West Virginia Network for Educational Telecomputing" (hereinafter called simply the "State Plan"). Approval of this plan by the Board of Regents in March 1975 marked the official beginning of the WVNET. (This State Plan thus superseded the "original State Plan" of 1970--with hindsight, the original State Plan had been quite nicely formulated and had been a useful instrument.)

Recommendations of the State Plan

Recommendations set forth in the State Plan were as follows:[1]

(1) That the WVNET be established.
(2) That the West Virginia University Computer Center (WVUCC) be the host site.
(3) That the Director report both to the WVU President (for WVUCC activities) and to the Chancellor of the Board of Regents (for network activities).
(4) That there be two Advisory Committees--one for Policy made up of Vice Presidents from the institutions and one for operations made up of the Computer Services Directors from each institution. (This latter committee thus superseded the former "Advisory Committee".)
(5) That existing staffs be upgraded.
(6) That the Policy Committee develop a revolving five-year plan.
(7) That all equipment be acquired centrally.

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[1] Portions of the material in this and subsequent sections were abstracted from a paper "The West Virginia Network for Educational Telecomputing" presented at the Ninth Hawaii International Conferen : on Systems Science, Honolulu Hawaii, January 1976, by Mr. Richard H. Bryan, Assistant Director for Network Services, WVNET.

(8) That each site maintain a staff to meet instructional, research, and administrative computing needs using the WVNET facilities.
(9) That a feasibility study be conducted concerning centralizing and using common administrative systems.
(10) That monies be accumulated to meet future hardware costs.
(11) That all sites be "captive customers" for three years.
(12) That private institutions of higher education in West Virginia be encouraged to join the WVNET.
(13) That at some future time the WVNET be operated as an auxiliary service.

Hardware/Software

The configuration recommended in the State Plan consisted of a central complex, dedicated telephone lines, remote batch terminals and interactive terminals. Each remote site would have a direct line to the host site, thereby creating a "star" network.

The plan recommended that the host site continue operation of the IBM 360/75 and acquire an additional IBM 360/65. One of the machines was to be designated primarily for administrative use while the other would be used principally for research and instruction.

Each of the twelve remote sites was to have an RJE terminal (HASP workstation) and conversational terminals which would communicate with the host site via hardware multiplexers, modems, and a telephone line. A thirteenth site would continue to use a small Data 100 batch terminal. The remote sites would return all the existing (rented) hardware to the vendors. This included three Data 100 batch terminals, five IBM 1130 computers, two IBM System 3 computers, one IBM 360/22 computer and one NCR 101 computer. The total number of conversational terminals was to be 38 after all were installed.

Budget Considerations

It was never intended that "money be saved" per se by creating the Network. Intent lay in attempting to bring decent computing power to bear on all the needs of all the schools. A number of the schools were then struggling with hardware only marginally sufficient to meet needs.

It was foreseen that costs overall would continue to increase in the years ahead, but it was seen that the increases would be more modest by employing a network than they would be if there were no network. This view seems valid thus far.

IMPLEMENTATION

Acquisition of Host Site Hardware

During the period March 1975 to June 1976, various equipment acquisitions were made.

At the host site at West Virginia University, the proposed "used 360/65" which was to supplement the existing 360/75 fell by the wayside as no attractive offerings were made by "used" vendors in response to our formal solicitation. After further study, an IBM 370/145 was acquired on rental, and the 360/75 was considerably upgraded by adding another 1024K bytes of high speed memory (taking us to a 2 meg total of fast memory).

Acquisition of Remote Site Hardware

A round of "request for proposals" for remote site hardware was effected, followed by more study, followed by a formal "sealed bidding process". We were able to get quite a bit more capability at the remote sites for the money we had to spend than we had expected. We were able to install nicely configured Digital Equipment Corporation PDP 11/40's throughout the Network (less one site which has a PDP 11/10).

Each system consists of the following hardware: (1) a PDP-11/40 with 32K words of memory; (2) 2 disk drives (2.3M words total); (3) one 9-track tape drive; (4) a 600 cpm card reader with mark sense capability; (5) a 600 lpm printer; (6) a synchronous interface; (7) a console CRT; and (8) a 16-line asynchronous multiplexer. One system has a second line printer.

The software includes the following: (1) a HASP Workstation emulation package; (2) Fortran with Commercial and Scientific Subroutine Packages; (3) Multi-user Basic; (4) RPG-II; (5) a Batch Stream Monitor; (6) an Assembler; and (7) two operating systems (RT11 and COS 500) which allow: (a) two of three systems (Multi-user Basic, HASP Workstation, Batch Stream) to run concurrently, and (b) batch operation of RPG.

Communications

Each of the remote sites is served by a leased telephone line. Most service is at 4800 baud, with some at 9600. The phone lines are a subset of a larger package of lines which State government has acquired. We pay about 25% of what a leased line would normally cost. Service to remote conversational terminals from the host site is incomplete at present, but service directly from the PDP 11/40's exists. Additional hookups to these conversational terminals from the host site should be in place by Spring.

Capabilities Available to the User

The batch services offered are similar to those at most large university installations. We offer a full range of compilers. We offer most of the usual "packages" for engineering, business, economics, and the like. Our offerings in "statistical packages" are particularly handsome. Mark IV is available, and is heavily used. There are, however, no offerings of what most of you would call a "data base management system".

Conversational services from the host site include "York APL", CPS, Wylbur, and IRS (an internally developed documentation retrieval system). BASIC is available out of the PDP 11/40's.

OPERATIONAL STANCE AS OF DECEMBER 1976

Business is Booming...

Business is good! Demand for our product runs high! We have many satisfied customers. Our "assembly line" is running well and by another month or two, after more "tuning" of the system, we should be running at nearly full capacity.

What more could a businessman ask for, you say? Well, we do indeed have some shortcomings, concerns, and worries...

Operational Concerns

As of this time, principal operational concerns include (in no particular order):

1. Being able to know at all times exactly what kinds of users are using what quantities of computing for what purposes, i.e. we need a good, solid audit trail of usage;

2. Ensuring that our pricing structure is fair;
3. Ensuring that our priority/scheduling algorithm is responsive to user needs;
4. Ensuring that some decent level of information security exists;
5. Attempting to get a decent mix of tape utilization vs. disk utilization;
6. Pushing ahead with improved "resource allocation" mechanisms;
7. Gaining a workable, satisfying ability to monitor systems performance;
8. Making sure we are employing each of the two cpu's well;
9. Performing some kind of meaningful planning for the future;
10. Learning to employ the computer power of the remote DEC PDP 11/40's well and fully, in conjunction with the computer power of the host system.

On the one hand, I am quite proud of our attempts to provide a workable, satisfying network with what I consider to be modest hardware and with little increase in personnel. On the other hand, I know of no other computing venture attempting to serve this large a clientele with this quantity of computer power. So one can't help but worry....

A key to future success, or lack of it, I feel, rests quite heavily in how well we will be able to utilize the full computer power of the remote PDP 11/40's with that of the two cpu's at the host site.

Funding Concerns

The State Plan set forth a certain spending pattern for five years. We have doggedly pushed ahead following these spending patterns. We are "on budget". (As a note of interest, those of us who were involved with the early planning somehow managed to completely forget about the possible impact of inflation--this is causing quite a bit of worry now.)

We are sufficiently funded to operate this fiscal year, and presumably the next, under the assumption of employing the 360/75 and 370/145 (with a 148 planned to replace the 145 next July). But will this quantity of hardware prove sufficient? In my judgment, the hardware will probably prove sufficient to meet need, but not sufficient to meet demand!

Organizational Concerns

At present, the position of Network Director and the position of Director for Computing Services at West Virginia University are filled by the same person. This was by intent at the time of starting the Network--or, perhaps, one should say that this was an expedient at the time (as was the case).

This "wearing of two hats" has caused concern among users. The West Virginia University users claim the "other guys" are getting too large a share of computing and/or attention--the other users in the Network claim the University gets too much. The Director often gets confused as to which "hat" he's wearing--other personnel of the host site similarly get confused as to their roles or allegiances at any given instant. This seemingly "goes with the territory."

At this time, it appears that an organizational change is imminent.

EFFORTS TOWARDS DEVELOPING "COMMON ADMINISTRATIVE APPLICATIONS SYSTEMS"

One of the mandates of the State Plan was to "develop common administrative applications systems." Those of us who are most involved, *viz*. all the Computer Services Directors at the Network schools, "kind of know" what we mean. Yet, considerable latitude exists in how to push ahead. I believe we are also generally aware that we could mess things up pretty badly if we were to push ahead imprudently.

Bearing in mind that we want to eventually move into "modern knowhow" (i.e., MIS, DBMS, or whatever buzzwords one prefers), but bearing in mind also that one must survive day-to-day in the meantime, we intend to push ahead by trying to develop a few modest, but meaningful, systems during the next year or two.

Quite possibly, we are talking about a common "ledger or accounting system", or maybe a "personnel system", or some form of "student records" processing. Perhaps, we should modify West Virginia University's "payroll system" to serve all.

In the short term, we are almost surely talking about employing "older knowhow", perhaps a set of well written COBOL or PL1 programs, with careful, meaningful, innovative thought being given to such seemingly mundane areas as file layout, disk pack layout, minimization of run time, and the like. I should sincerely hope we would include a means whereby some appropriate kind of "preprocessing of data" at the remote PDP 11/40's could occur.

Why is there merit in staying with this style at present? Because one must survive (and hopefully make life more bearable in the short term) while formulating the future. I must emphasize that as of now we are just getting a start on this effort. We remain about two people shorthanded as I reckon it, and we are having trouble defining exactly which need is most needy! But, we should be making some progress this Spring...

OPPORTUNITIES FOR DISTRIBUTED COMPUTING

First, let's make sure we're using the same buzzword definitions.

A "simple network" is one comprised of a central host system with remote batch terminals accessing the host. A "multi-function network" is comprised of a central host system with nicely configured remote minicomputers accessing the host. These minicomputers should include printers, card readers, sufficient main memory, secondary storage (tape and disk drives), and connected low speed terminals.

In a narrow sense, WVNET is then a "multi-function network." Or is it? Only if one cleverly employs the full capabilities of the remote minicomputers. And we're surely not doing that yet in WVNET.

We have some attractive opportunities at hand--opportunities which match up to our equipment and to the present knowhow of the people in the network.

Just for starters, as illustration, consider the payroll application. At present, each school is pretty much on its own as it processes its own payroll information leading up to a final step wherein the State issues the payroll checks from the State's computer system in Charleston.

Consider how attractive the following procedure would be as an alternative:

1. "College X" runs its raw payroll data against a modest "critiquing program" using the PDP 11/40 in standalone mode;
2. An exception report is produced locally with good turnaround time;
3. Local payroll personnel examine the exception report, juggle "trial balances" as appropriate, and perhaps make several quick reruns as necessary;

4. "College X", now satisfied with the raw data, ships the data down the phone line to the host site;
5. The host site, having collected the payroll information from all schools, executes a single run which culminates in a computer tape being shipped "to Charleston" (at which time everyone involved can simply sit back and await delivery of the paychecks).

Other examples of how one could employ WVNET's hardware are easy to spot. And, one has only just begun to be clever. The illustration above is "bush league" in its artistry, but attractive nonetheless. Similar opportunities for serving students, professors, and researchers with their needs exist.

HOW CAN WE EVOLVE TO AN APPROPRIATE STANCE IN MIS AND/OR DBMS?

What Do We Mean?

Again, it's probably helpful to clarify usage of the buzzwords. Our thinking on a management information system is basically that implied in the usual triangular drawing which displays, from top to bottom, (1) MIS for strategic and policy planning, (2) management information for tactical planning and decision making, (3) management information for operational planning, and, finally, (4) transaction processing. Almost surely, in our case, we're talking about batch rather than on-line processing--and we would certainly aspire to employ "distributed processing", as appropriate. By "data base management system (DBMS)", we are thinking along the same lines as most of you at this conference, viz., some software system for manipulating large data bases--one which appropriately interrogates, maintains, and analyses the information at hand.

Evolving to an MIS Stance

Clearly, at this time, we have some elements of an MIS which could form the basis of some "grander scheme of things." West Virginia University has a number of systems (e.g. payroll, budget, and financial aids) which are of recent vintage and work well. These individual systems are certainly MIS-like in that they satisfy the notion of the "triangular drawing" mentioned in the previous paragraph. They are, however, not as interlocked with each other as one might like.

These systems, and others, could be expanded upon with a finite expenditure of manpower. All schools could run against common systems. Many of the benefits implied by the "triangular drawing" would be realized.

Several of the smaller colleges also hold some specific application programs which are quite satisfactory. Some sharing already exists. Effort on expanding these could be considered.

Certain common programs for the processing of information leading to certain "Board of Regents reports" are in use. These could be enhanced.

All of the usage noted would be behind state-of-the-art COBOL- or MARK IV-type processing. But, if the programs work, and are satisfying, and get the job done...

Although we do not feel that a DBMS is mandatory for a satisfying MIS in the short term, many of us feel that a move toward some specific DBMS is appropriate some day quite soon!

Evolving to a DBMS Stance

There is, as yet, no formal move being made toward a DBMS acquisition. Yet, some efforts have been undertaken which seem right and proper toward the end of getting us there someday.

At this point in time, it appears preordained that wherever we end up will be strongly influenced both by the needs at West Virginia University and by the manpower which can be brought to bear at the University in the years immediately ahead. I feel there is nothing alarming about this situation. Properly overseen, much good can come from recognizing that the "dog" (the University) must, of necessity, "wag the tail" (the rest of the Network) in certain efforts.

For a number of years, the "style" of data processing at West Virginia University has been what I'd call "old fashioned"--nonetheless, this "style" proved satisfying to needs. Now, however, one sees signs of inadequacy in meeting information needs.

But, there has been some truly encouraging progress by West Virginia University recently. An "Administrative Information Group" drawing together the bulk of the previously far flung "administrative computer people" was established in July. Experienced personnel have been added. An increased top level management awareness at the University of the need to improve and/or "tighten up the operation" exists. Better efforts at organizing the day-to-day job scheduling are being made. After some years of false starts, active work on a "data dictionary" is underway. All these signs are most timely and encouraging. (Let me add, also, that I see some encouraging signs at several other institutions in the Network which seem to depict "awareness" at the computer center level and/or "top management level.")

I should hope that personnel from West Virginia University along with personnel representing the Network *per se* can begin shortly to actively ponder alternatives for pushing ahead.

While many of you have been pushing ahead with DBMS in the past few years, we have not. This does not alarm me and I should hope we can profit by having had some "pioneers" go before us. I don't feel it's too late by any means if we move ahead prudently in the next few years.

A key factor in pushing ahead will be whether or not this same *top level management awareness* coupled with the providing of appropriate resources can be established and/or maintained at all of our State's higher education institutions. The various "computer people" (i.e. the "working people", if you will) in the Network, at all sites, are talented and resourceful. Lack of experience exists presently, but this can be overcome.

SUMMARY

The computer capabilities within WVNET are superior, overall, to those which existed in the recent past. This has been accomplished at modest extra cost. When one includes the added costs of the capabilities which would have to have been added at a number of the schools even had there been no network, we are saving money.

The *de facto* network of the earlier days, 1969 to 1974, evolved because "it was a good idea." The subsequent growth came because of a mandated course of action from the Board of Regents. Although other persons in West Virginia higher education (or higher education anywhere else for that matter) might like one to believe otherwise, I honestly feel that the network was mandated due to valid economic and technological reasons, not (using the popular term) for "political reasons."

Assuming we all work hard, and assuming that reasonably decent funding is provided, I feel there is much promise for the future. I feel we have progressed nicely thus far.

THE OBSOLESCENCE OF THE UNIVERSITY DATA BASE SYSTEM

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The University Data Base has become oversized, unwiedly, overly complex, and tempermental. With expensive tastes and unrelenting demands, it tends to rule its users rather than support their information needs. It is time we realize the data base concept has been badly misused and the forced co-mingling of data does not guarantee an information system. The data base must be broken down into controllable units. This paper discusses how modern resource management techniques such as specialization, division of labor, delegation of authority, and departmentalism, could be effectively applied to computer as well as to human information resources. The technology for stripping the data base of its awesome control is available today.

The Obsolescence of the University Data Base System

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The use of the large-scale data base system in the university is no longer a novel concept. In fact, the literature of higher education in the past several years has included countless tales of the perils and struggles surrounding the attempts to control such systems. To date most of us, these authors included, have insisted that the reasons for problems and for failure have been in the users and not in the systems themselves. We have repeatedly stated that with proper foresight and planning and continued supervision, a data base system can produce all the results it promises. The very emphasis on the Data Base Administrator was a direct result of warnings that data base systems are difficult to control and need very careful supervision by a staff of super technicians, teachers, and diplomats. Numerous articles have chastised the data processing manager, the university administrator, the vendor, and the programming staff for not defining the future environment properly; for not investigating future interfaces deeply enough to prepare proper structures for the initial data; for not systematically evaluating needs versus capabilities of the prospective DBMS, for over-selling the product too early; for embarking on a first system that was too large and too critical; for cutting controls and edits and error traps in order to meet unrealistic schedules; and -- last but certainly not least -- for buying (or selling) a DBMS in the first place.

Each and every one of these criticisms was apt to a large class of early data base users; many of the errors are still being repeated. However. Although there are now many successful and cost-justified DBMS environments in our colleges and universities, there are also countless uncontrollable, ever-growing, demanding data base systems about which unhappy administrators ponder where they failed, when in fact they were guilty of none of the short-sighted planning or poor implementation techniques cited earlier. The planners and implementors were capable. The early systems were successful. But the system grew through time to become unbearable. Those responsible wonder why. The answer to the quandary is, we think, often inherent in the data base management systems themselves.

Typically the problem revolves around the fact that the maturing DBMS insists on "running the show". Its peak demands dictate the rescheduling of other non-data base systems, even other users, in order to satisfy CPU and memory requirements. Its dependence on a given structural relationship forces conformity among all kinds of data. Its rules for developing interfile or "inter-data-base" relationships place further restrictions on the structuring of infrequently but definitely related data to the frequent detriment of the more commonly accessed patterns. The fragility of the typical backup/recovery system imposes further restrictions on the usage pattern of the entire system to protect the integrity of the data base.

In its infancy the above problems are not usually noted at least not with much concern. The first data base applications tend to be ones whose natural structures match those of the DBMS, usually because these applications are very frequently the very ones which caused the selection of the particular DBMS in the first place. These initial data bases are usually of a manageable size (and frequently test or pilot applications) so that backup/recovery weaknesses are not stressed and failures are not viewed with great criticality.

Through time the data base grows and becomes accepted, even depended upon. Patterns of usage and response expectations are established. Various applications finally reach production usage. The installation becomes heavily committed to the DBMS. However, the typical data base grows beyond its initially carefully planned phases.

Often this growth is a positive indicator of the usability of the data base concept. Unfortunately, this is the point at which the weaknesses of the DBMS begin to make themselves known. Much as the true serviceability of a new highway bridge cannot be tested until the old bridge is torn down, thereby removing both user ability to avoid the new and builder ability to reinstate the old way should the new one fail, stresses on the DBMS are not usually great until the time and money commitment makes a new choice prohibitive.

This is the point at which interrelationship stresses appear. For example, suppose a student fees subsystem unexpectedly becomes a desirable addition to existing student and financial information systems and that this data is the only data thus far in common between the two systems. Depending on the DBMS, this would cause a redefinition of the original two files into one (in order to perform unprogrammed user queries), the programming of tailored application programs to "talk across" the files, the addition of the information to both files with resultant redundant data and higher updating requirements, or degraded access to the "awkward" data. Projecting this phase to a full and comprehensive university system, where almost every defineable file can be related to some other file (i.e., in a university it is difficult to find any single set of logical data which is totally isolated), one of the following usually results:

(1) One huge data base with all the data structured in a manner which attempts to produce reasonable response times for the critical high volume demand;

(2) Several large data bases, each structured as in (1) and with tailored support for interrelating the data bases;

(3) Many smaller data bases, each optimized for a given application and with most general accessing controlled by tailored programs.

Alternative (1) was, of course, the original ideal of the data base concept; one base containing all of the related data with little application support to access it. Most who have traversed the data base route, however, admit that few could afford the frontend planning time to predict accurately all future relationships and uses. Even if this could be done, university users fear that the sheer size of a single data base to serve their needs would be prohibitive from standpoints of processing speed, memory requirements, and the risk of downtime.

Alternative (2) is becoming more common. A compromise between (1) and (3), it attempts to avoid the bad drawbacks of each but demands a great deal of expertise on how to capitalize on the strong features of a particular DBMS.

Alternative (3) is actually evidence of a trend back toward more conventional data processing systems with high ongoing support for the programming of new systems and modification to existing ones. However, the use of tailored applications to relate files avoids the need for clairvoyance in the other two alternatives.

These alternatives to the structuring of the data base have much in common with those associated with organizational management. In the small organization a simple central structure works effectively. However, as the organization grows in size and complexity, direct communication by a president to all levels of a centrally-located homogeneous staff becomes awkard. To handle this problem modern resource managers have recognized the need to introduce smaller units of authority, to break the organization down into manageable parts. The concepts of specialization, division of labor, delegation of authority, and departmentalism have been successfully introduced.

The data base management systems of today have addressed a small subset of these organizational problems: they do provide specialized control permit limited partitioning of the data. However, basically logical divisions of the data are dealt with in a superficial (or external) way: user access to various data is restricted through complex security schemes; the data themselves are usually centrally stored in a highly interdependent manner. It is this internal structuring which places such high demands on the environment.

Because the external organizaional problems are dealt with effectively, the university manager has been slow in realizing that, with his large and highly interrelated data base, the demands of the internal organization can become exorbitant. The set of problems includes the following:

(1) Because of cost and interface problems, the university can usually support a maximum of one DBMS. Consequently, all data base systems must be structured according to a single DBMS, be it hierarchical, relational, or

something else. However, university data are ill-behaved and diverse. A structure which maps well for one system will not necessarily apply easily to other systems.

(2) Because the typical DBMS requires explicit relationships in order to perform automatic non-programmed processing, data structures must often queries.

(3) Because the various data become physically intertwined, the size of the entire data base becomes critical during any processing by the DBMS. For the maturing data base, this size will dictate the online peripherals and the machine memory for the entire installation.

(4) Because data base processing operates in the same environment and within the shared CPU, it will dictate strict backup/recovery patterns onto the non-data base applications.

(5) Because of the CPU sharing, it is difficult to design reorganizations and optimizations to automatically occur when load is light in the data base.

(6) In order to permit other systems to use the critical CPU resources, the installation manager will usually relegate the data base to a "parttime" status and remove it completely during certain periods. Because the DBMS is dependent on the CPU no data base access is possible during those periods.

(7) Because of the complexity of the data base system software and its dependencies on the CPU architecture, the installation becomes bound to a given computer manufacturer, the vendor of the DBMS, and the whims of both. In addition, even if a second CPU is available, it cannot be shared by the DBMS. Even if a second DBMS is available, it cannot be easily interfaced to the original one, much less to a common base of data or application programs.

the increments may be smaller and more economical, the load will still approximate the DBMS demand peaks (as was true in the mainframe setup) except that in the mainframe the peaks might have been counterbalanced by lower demands of other non-data base systems, thus permitting at least some resource sharing.

An alternative solution would involve combining the mainframe with one or more mini-computers which would perform data management services. Such a mini-computer is termed a "backend" since it is the product of offloading some portion of a data base management system from the mainframe "host" to an "outboard" computer which is the backend. By offloading data processing work from the mainframe to another intelligent device (much as terminal accessing is offloaded to a "frontend" processor), the CPU power and memory of the host can be used for other tasking, thereby extending the life of the mainframe. On the other hand, the decision to leave application support and an interface for natural language requests in the host provides the power and memory of the entire main CPU (and access to any non-data base peripherals needed) for complex application support while yet avoiding many of the security and backup problems associated with application interference with the data base and its access.

Since the backend performs actual data base I/O operations and because it contains the DBMS capabilities to digest and reformat the stored data, it possesses enough power to perform standard inquiry/retrieval functions in and of itself. Furthermore, since the backend is not sharing its cycles and memory with other applications, it is free to spend idle time in various tuning and

(8) Control hierarchies and security setups can be circumvented by a clever but malevolent programmer who modifies the ever-present operating system to bypass the DBMS entirely in accessing the data under its control.

In summary, the DBMS that shares the main CPU with non data base applications dictates the size, character, and power of that CPU. In addition, the DBMS becomes vulnerable to the other applications on the system and restricted by the demands of those systems.

These problems of the complex and large data base are finally being recognized and much work has already been done on the search for a replacement for the current type of data base management system.

Some of the researchers have become proponents of substituting mini-computer data base systems for the current mainframe systems. The arguments are substantial. By performing DBMS activities in a separate machine, the main CPU is free to handle other problems. Besides providing a manner of expanding which is more cost-effective than mainframe expansions, this method addresses other data base problems since interference with other concurrent processing is non-existent and backup/recovery is more controllable because the environment is restricted from non-data base applications.

However, the mini-computer DBMS shares certain of the problems with its mainframe counterpart: because any appplication support (which even most vendors will admit is a strong necessity) also resides in the mini, security circumvention is still an issue as is the problem of recovery from application program failure. Further, the mini also suffers from overloading of memory and cycles, only it occurs much more rapidly on a smaller device. Although reorganization function. In addition, it can be programmed to operate independent of the host, thereby giving it utility in tandem with the host or even when the host is not operable.

The backened could be thought of as the "workhorse" of the mainframe host, or, for that matter, for multiple hosts (since a simple interface would enable host-sharing). If designed so that its primary function is to handle all interfaces with the data base (as differentiated from traditional controllers which handle all interfaces with a data base device), the backend becomes a Data Management Machine (DMM). We might refer to the DMM as a "data munching machine". Since one of its greatest advantages is the fact that it acts as a data reduction device for the host: in the typical data base environment, the common data base function causes many device requests; thus by offloading device accesses from the host, that host is freed from much I/O handling and the intermediate buffering requirements.

The backened DMM also avoids several of the problems not solved by the stand-alone mini-computer DBMS. Because the user applications are resident in the host, the backup/recovery complexities caused by unrealiable applications are not a problem because the only way into the DMM is through its host interface access method, the risk of security circumvention via an operating system or external application which accesses the data base devices directly is eliminated.

The DMM concept has other advantages. Since the DMM contains all of the complex data management code, with little host-dependent DBMS code, and since the DMM could support multiple host accessing, the installation could utilize its DBMS from different types of mainframes and from distributed locations. Further, by introducing another DMM and a switching mechanism, the installation can improve throughput and reduce the risk of failure or downtime by servicing requests at a slower rate (i.e., degradation of performance rather than no performance).

In summation, for the university which intends to make substantial use of the data base concept, the DMM has the potential to avoid many of the pitfalls commonly experienced with the maturing data base system. However, even the DMM DBMS -- if it were currently available -- suffers from some of the problems of the mainframe DBMS, namely those problems associated with dependency on a particular vendor. The university manager will be dependent on the producer and supplier of his DBMS, and ultimately of his Data Management Machine. Thus, problems of reliability, problem detection, technical obsolescence, servicing, and the numerous disadvantages cited earlier of being dependent on only one costly and restrictive product will continue to exist. However, the Data Management Machine would certainly be one means of beginning to strip the data base of its awesome control over our information-producing organizations.

A MINI FOR MANAGEMENT

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This paper discusses a system that serves as a responsive administrative information resource to high-level university management, college deans, and department heads at the same time it is being used for daily operations. It has an integrated data base, is on-line for both inquiry and update, and runs on a mini-computer. The data base includes financial data, student files, and personnel detail such as faculty activities and academic performance. An illustration of management use is the Vice President of Academic Affairs using the system to study faculty loads, personnel costs per credit hour, library resource consumption, and departmental manpower allocations. A college dean may use the system to examine the impact of service course instruction.

A MINI FOR MANAGEMENT

Introduction

Colleges and universities are on the brink of discovering that minicomputers are a viable alternative to midi and maxi hardware for administrative data processing and management information systems. With a history of solid performance for highly technical users, the minicomputer has emerged as a low-cost contender in the medium to modestly high performance range for those of us who are less sophisticated in technological detail.

Minicomputers are not new. Data base management systems (DBMS) are not new. But the advent of high quality data base management software on minicomputers is recent. The use of such a system in the development of a so-called management information system (MIS) is only now being seriously explored.

Such a system has been developed at the University of Wyoming and is being used to support daily operations, management decision making, administrative data analysis, and some high-level planning. The minicomputer used is a synthesis of technical developments which is unique. A full configuration is modestly priced and performance rivals older hardware costing eight to ten times as much. The system has an integrated data base and is on-line for inquiry and update. The data base is people-oriented (rather than financial) and includes student files and personnel detail such as faculty activity and academic performance, as well as some financial data. It is being used throughout the University administration and particularly in the academic/faculty area. The system developed at the University of Wyoming illustrates use of a minicomputer to support activities formerly thought to require larger (and more expensive) hardware. In addition, the management activities supported by the system are thought to be of considerable interest to other universities.

The Problem

Much has been written about the problems facing university administrators today. The list is long and the problems are often very complex. In response to the call for help, enthusiastic data processing technicians have misrepresented and oversold computer automation as an answer to the administrator's dilemma. As deadlines passed and funds were expended beyond estimates, a disenchantment set in. "Unfulfilled expectations" and "disappointment" described the results of all too many management information system projects.

With administrators and technicians wiser for the experience, we are seeing the dawn of a new perspective on the use of computers in high-level administrative problem solving. Of major importance in this perspective is the understanding that the computer is nothing more than a tool which is useful in manipulating and managing large quantities of data. Along with this understanding has come the realization that a management information system is more than a set of computer programs. It is now recognized that a management information system is really a management support team with a computer system as a common tool. The computer component must include good data base management software, a data resource consisting of an integrated file set, some generalized programs which may be used to respond to a variety of unanticipated requests, an adequate assembly of hardware, and a talented staff capable of keeping it all working. Some members of the MIS team must collect the data and load it to the data base. Often this is a problem of speed, accuracy, and thoroughness. Other members of the team must be capable of probing the data base for combinations or selections of data that will provide information to the administrator. Often this is a problem of communication, timeliness, and adequacy (of the data resource). Still other team members must resolve security, design, access, responsibility, and a host of other problems that arise whenever several different offices around campus are involved.

The demands on the support team usually exceed that which can be satisfied by information. Herein lies the source of much confusion and discontent. It is incumbent upon management to realize that the management information system will do no more than it is designed to do. It does not make decisions. It will not solve management problems. It will not produce information that is based upon data not collected. Management must make the decisions, people must solve the problems, and administrators must articulate their data needs.

At the University of Wyoming, the management information team consists of the president, four vice-presidents, several college deans, a representative of the Faculty Senate, and a data base administrator. In addition to carrying on the daily business of the University, this group is responsible for the data resource and is a user of information from the system. They respond to inquiries from the Wyoming State Legislature regarding budget, faculty activity, departmental position allocation, credit hour costs, etc. For internal management they use the data to study course loading, faculty assignment (research, instruction, service, committee work), and publication type and volume. They work on grant acquisition and management through skills inventory and academic interest data. Academic programs are examined for cost/benefit by a study of enrollment data, course level, student degree type, student level, etc. Response to Federal and institutional questionnaires is done as needed. A recent development is the use of the system by the Faculty Senate to support interaction with both faculty and faculty administration.

The problem, then, is one of assembling and educating the team, collecting the data, and responding to the variety of perceived information needs.

The Computer Support System

Using a computer is a common experience for many administrators. Using a minicomputer is less common. Back in the days when computers were first coming into wide use there was an affinity developed between men and hardware.

Computers were a hands-on tool that were approachable though mysterious. As data processing centers grew larger and more impersonal, the affinity was lost. The large, complex computer system became the tool of the cybernetic professional. When management needed information it was no longer available directly from the computer. It was necessary to make a request to the data processing organization which in turn used the computer and responded to management's request on a schedule, in a manner, and at a cost that was often insensitive and alien. Aside from all else that minicomputers offer, the return to personal computing with hands-on contact is possibly the most significant factor in their widespread use. Again, it is possible to have an affinity with the hardware in much the same way a family grows close it its automobile. There are many things that minicomputers can't do or don't do well. But, like the family car, these are overlooked as long as the job gets done. As the discussion of maxi versus mini goes on, it is worth noting the gleam in the eye of the owner of the mini ... a gleam that may be signaling the beginning of a great new American love affair. And, after all, what technical argument can hold its own when love is involved?

The return to personal computing, though very real, is being stemmed by computer professionals. Programmers, analysts, and computer center management are using minicomputers as their personal tools to do what midicomputers did in the past. The traditional file structures, languages, and systems designs are being reinstalled on minicomputers daily. The effect of this trend is to preserve the present gulf between the administrative user and the computer resource. We are finding that minicomputers are still being used as tools for programmers rather than as tools for administrators. Although the hardware expense is less, the cost of developing applications is still high and the time lags are very long.

The notion of personal computing for administrators is being actively pursued at the University of Wyoming. The minicomputer being used significantly departs from the past in providing services directly to administrative users and is a data resource under their control in much the same way a filing cabinet is under their control. They determine what goes in, how it is filed, and how it is used. Of course, the minicomputer system provides many processing capabilities not available in a filing cabinet.

At the University of Wyoming, three minicomputers are being used for administrative data processing in Laramie and two more have been set up at community colleges. These systems have a combination of hardware, firmware, and software that returns control of the computing resource and the data resource to the administrative user. Use of the system requires very little training ... a couple of hours gets people started. Some applications don't even need special programming. For these the generalized services are sufficient. Projects requiring special programming, like the MIS, require as little as one-tenth the development time of previous comparable efforts using traditional methods.

Figure 1 shows one of the minicomputers with a magnetic tape drive, a disk storage unit, low-speed printer, and console CRT terminal.

The Data Resource

Within the University data is collected on a variety of forms, kept in many different offices, and used for an unknown number of purposes. Gathering the data needed for a management information system is a large and difficult task. The rule governing the collection of data is that the accuracy and timeliness will be improved if those responsible for supplying the data benefit from doing so. This means that if a college dean is expected to input data to the system, there must be a return benefit to that dean which is a direct result of and is dependent upon the data entered.

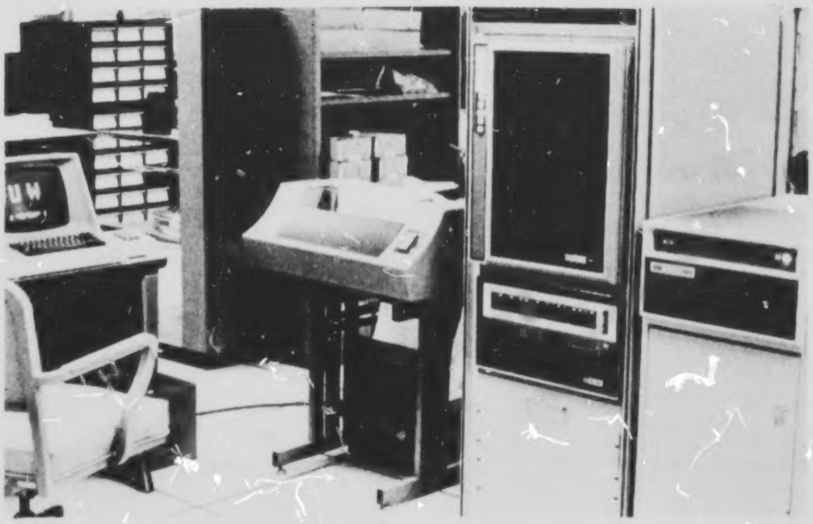


Figure 1

The initial phase of the MIS data base at the University of Wyoming has resulted in the collection of a large volume of data about personnel. Included are:

- Faculty service records with annual supplements,
- Faculty performance evaluations,
- Faculty resumes,
- University committee assignments,
- Instructional work load of faculty and teaching assistants,
- Student data base with current semester course enrollment,
- Personnel/Payroll file,
- Faculty publication records, and
- Faculty fields of interest and expertise surveys.

Soon to be added are the accounting files.

Since much of this data is very sensitive, considerable security surrounds its use. Safeguards are built into the computer system and external measures have also been implemented.

Sample Use

The system consists of a minicomputer, some generalized services, some specific services, an integrated and shared data base, and some TV-type terminals. Figure 2 shows one of the types of terminals used.

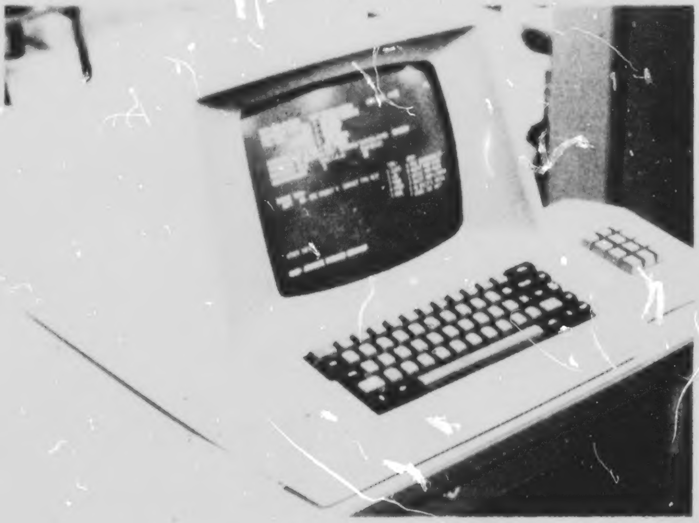
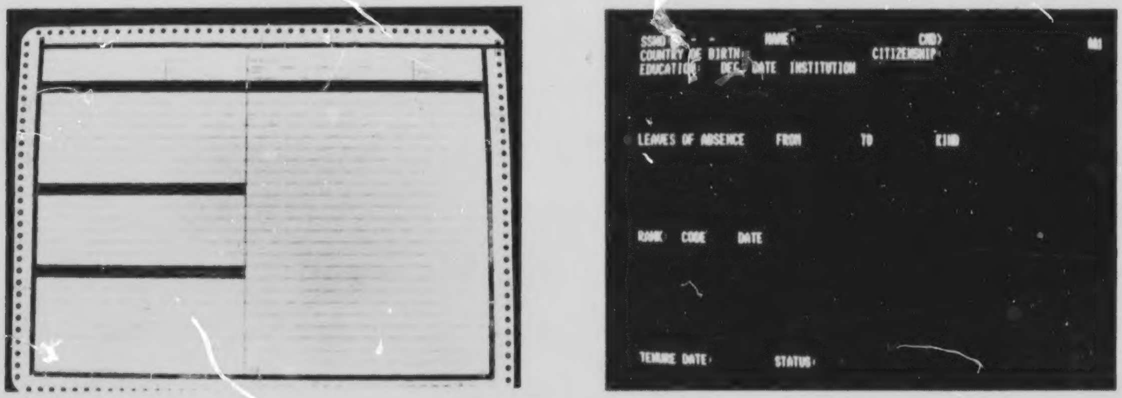


Figure 2

Data is entered on the computer by a clerk using one of the terminals. A form is displayed on the terminal screen that is very similar in layout to the document from which the data is being taken. This is illustrated in Figure 3.



```
SSNO: - -          NAME:                  CMD>               AA:
COUNTRY OF BIRTH:                  CITIZENSHIP:
EDUCATION:   DEG  DATE  INSTITUTION


LEAVES OF ABSENCE    FROM       TO        KIND



RANK  CODE   DATE

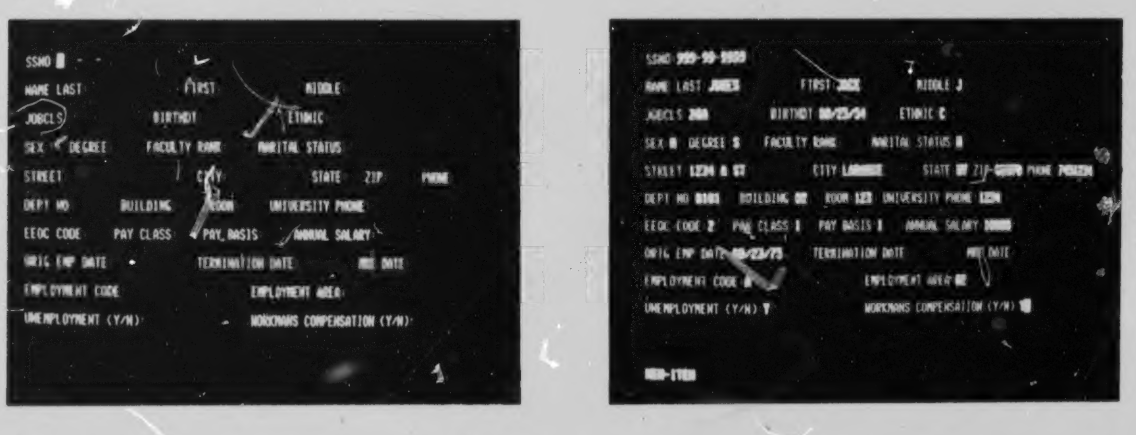



TENURE DATE:          STATUS:
```

Figure 3

With the form on the screen it is possible to enter new data, correct existing data, display stored data, and delete data. Examples of how the system is used for daily operations, data analysis, and as support to planning and decision-making are given below.

Daily operations presently include personnel/payroll and student records management. Accounting is to be added during 1977. Much of the basic data about people that is needed for management purposes comes from normal university operations. This is illustrated in Figure 4, which shows a terminal screen format used by the Personnel office to update personnel records. By using the terminal it is possible to add new employees, change data, delete those who terminate, and obtain many different reports.



```
SSNO  -  -
NAME LAST              FIRST             MIDDLE
JOBCLS             BIRTHDT            ETHNIC
SEX  DEGREE        FACULTY RANK       MARITAL STATUS
STREET                 CITY                 STATE   ZIP       PHONE
DEPT NO        BUILDING        ROOM       UNIVERSITY PHONE
EEOC CODE    PAY CLASS     PAY BASIS      ANNUAL SALARY
ORIG EMP DATE            TERMINATION DATE          [illegible] DATE
EMPLOYMENT CODE                      EMPLOYMENT AREA
UNEMPLOYMENT (Y/N)                   WORKMANS COMPENSATION (Y/N)
```

```
SSNO 999-99-9999
NAME LAST JONES          FIRST JACK          MIDDLE J
JOBCLS [illegible]       BIRTHDT [illegible]     ETHNIC C
SEX M  DEGREE S    FACULTY RANK       MARITAL STATUS [illegible]
STREET 1234 A ST            CITY [illegible]       STATE [illegible] ZIP [illegible] PHONE [illegible]
DEPT NO [illegible]  BUILDING [illegible]  ROOM 123  UNIVERSITY PHONE [illegible]
EEOC CODE 2  PAY CLASS 1  PAY BASIS 1   ANNUAL SALARY [illegible]
ORIG EMP DATE [illegible]   TERMINATION DATE          [illegible] DATE
EMPLOYMENT CODE [illegible]              EMPLOYMENT AREA [illegible]
UNEMPLOYMENT (Y/N) Y                     WORKMANS COMPENSATION (Y/N) [illegible]

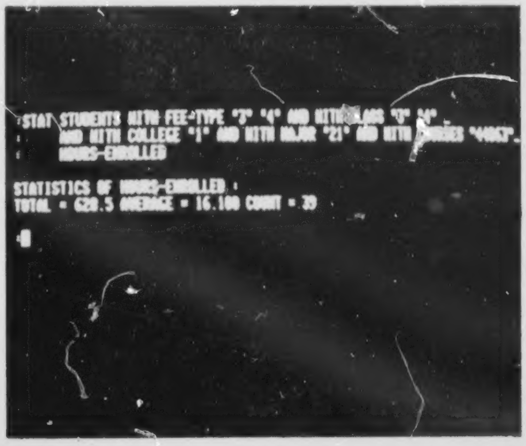
[illegible]
```

Figure 4

Inquiry into the data base is also done using the terminal. The response may be displayed on the terminal, printed on a printer located near the computer or printed on a printer attached to the terminal. The English-like inquiry language makes it possible for the users to request reports or browse through the data directly without having to go through the data processing organization. Of course, access to and modification of the data is regulated by security procedures in the computer.

Recently the Assistant Registrar was filling out an H.E.W. report and needed the answer to the following question: "What is the average number of hours that a full-time junior or senior political science major taking political science courses at the graduate level is enrolled for?" Figure 5a shows him typing in the inquiry and Figure 5b illustrates the response on the terminal screen.

5a



```
:STAT STUDENTS WITH FEE-TYPE "3" "4" AND WITH CLASS "3" "4"_
:     AND WITH COLLEGE "1" AND WITH MAJOR "21" AND WITH COURSES "4063"_
:     HOURS-ENROLLED

STATISTICS OF HOURS-ENROLLED :
TOTAL = 628.5 AVERAGE = 16.100 COUNT = 39

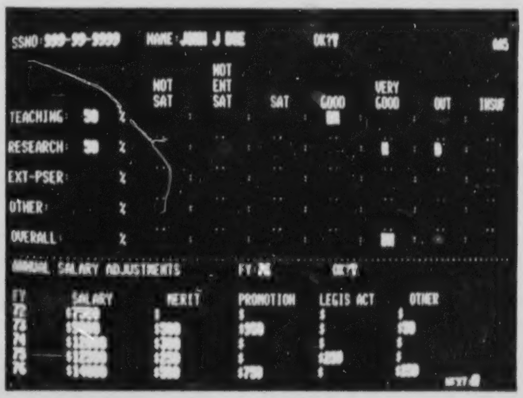
:
```

5b

Figure 5

Because only one copy of basic data is kept about each person in the data base, management is always assured that their use of the system is based upon the most current data possible. However, some of the data needed for management is not used for daily operations. This also must be collected and loaded to the

6a



```
SSNO:999-99-9999   NAME:JOHN J DOE          OK?Y                    [illegible]
                                NOT
                      NOT       ENT                      VERY
                      SAT       SAT     SAT     GOOD     GOOD     OUT     INSUF
TEACHING:  50  %
RESEARCH:  50  %
EXT-PSER:      %
OTHER:         %
OVERALL:       %
.................................................................................
ANNUAL SALARY ADJUSTMENTS            FY:76          OK?Y

FY      SALARY          MERIT       PROMOTION     LEGIS ACT     OTHER
72      [illegible]     $           $             $             $
73      [illegible]     [illegible] [illegible]   $             [illegible]
74      [illegible]     [illegible] $             $             $
75      [illegible]     [illegible] $             [illegible]   $
76      $14000          [illegible] $750          $             [illegible]
                                                                      NEXT?
```

6b

Figure 6

data base. The responsibility for the collection of the data rests with the administrative office that uses it. Figure 6a shows a clerk loading annual merit ratings for the Academic Affairs Office and Figure 6b is an illustration of the screen format she is using (the screen format has been filled with sample data).

Data analysis at this point in time is primarily confined to the use of the generalized inquiry capability of the system. One simple illustration is shown in Figure 7, which is a response to an inquiry from a vice president regarding fall semester classes with less than ten students enrolled.

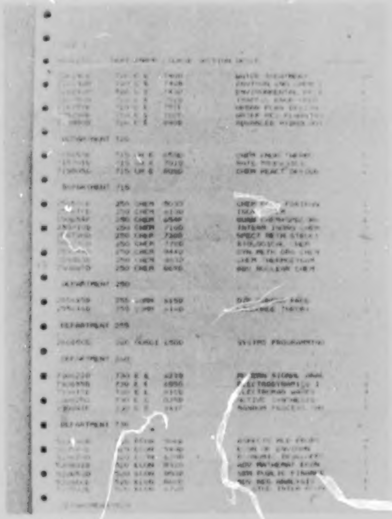


Figure 7

The system is also being used to study discrepancies between reported instructional responsibilities of faculty and those of graduate assistants. This study is supported by a specific service which is a program that produces the reports shown in Figure 8.

Other examples of analytical use includes the comparisons between academic colleges on faculty course loading, number of advisees (by degree type, etc.) student credit hours generated, courses per faculty position by course level, and publications in relation to research and teaching assignments. The system

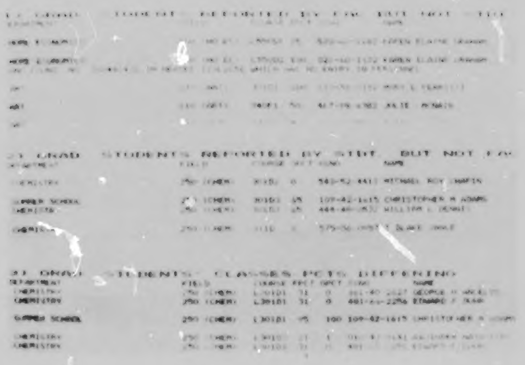


Figure 8

does not directly display these comparisons but rather facilitates the study by rapidly accommodating the examination of the data. Since the data displayed by the system in support of this type of work is confidential, it is not possible to show an illustration in this paper.

Planning and decision making is an outgrowth of data analysis. A later phase of the development at the University of Wyoming will include modeling and simulation. So far, the system has been used to plan for faculty position allocation rearrangements within and among the academic colleges. Also, the minicomputer has been used in a limited way in budget planning and development. However, this activity has yet to be integrated into the management information system.

Data Collection

The data base has been assembled from many sources. Basic payroll/personnel and student data was converted from files used on a larger computer. Some faculty data was converted from manual files. Other data came from questionnaires sent to faculty and graduate teaching assistants. Figure 9 illustrates the data sources for the initial organization of the data base. The conversion of manual files is a massive one-time effort. Conversion of computer files is a several-time effort as applications are run in parallel on two computers.

Questionnaires are periodic and on-line updates are daily.

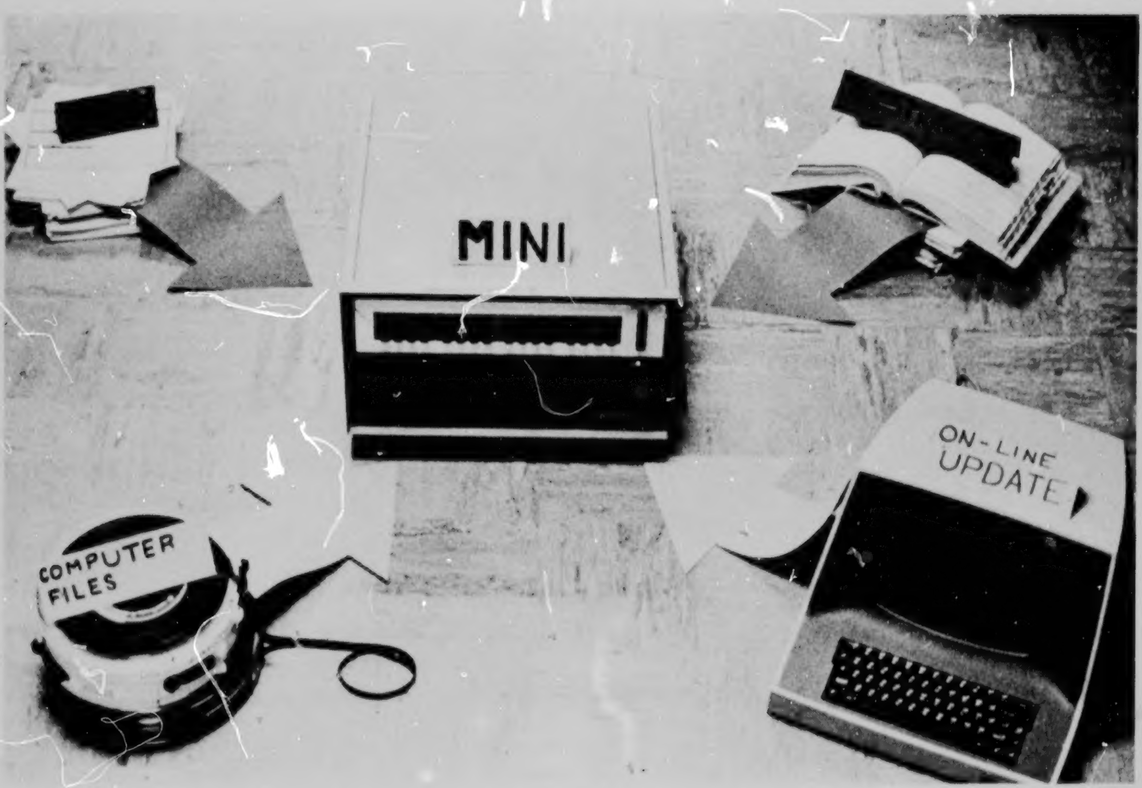


Figure 9

Of particular significance is the fact that data capture is done by personnel in the office responsible for the data. This means that payroll data is loaded by people in the payroll office. Faculty activity data is loaded by people in the office of the Vice-President of Academic Affairs and Provost. The entry of data by those at both the daily operations and management levels produces a rich data resource that is shared to the benefit of all. Figure 10 shows people in the Personnel Office and the Provost's Office using the system.

Figure 10

Conclusion and Future Plans

The minicomputer at the University of Wyoming has proven to be a successful tool for direct use by management. The hardware is reliable and inexpensive. The management information system is directly usable by people of varying skill levels ranging from clerical to top management. It is possible to do daily operations, data analysis, planning/projection, and system development simultaneously.

There are six phases to the MIS project. With phase two completed, the system is being used by the University management on internal matters and will be used during the upcoming session of the Wyoming State legislature. The data base is adequate to support these activities.

Future plans include enhancement of the data base management system, enrichment of the data base, and enlargement of the user community.

The DBMS works very well on single key direct access record retrieval, but needs improved performance on processes requiring multiple key access or large file sorts.

The data base consists primarily of data from existing manual files or data which is already being collected. For instance, faculty assignment data is used rather than actual activity. Plans include the inclusion of many additional data types. Also, the financial files of the University are to be integrated into the data base.

Finally, use of the system will be extended to academic college deans and department heads. This will give academic administrators and university officers a shared management tool.

THE "PACKAGED" APPROACH TO MIS: HEPS vs. NCHEMS

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The dissemination and use of NCHEMS software (student Flow Model, Costing and Data Management System, RRPM-1.6, etc.) has had a definite impact on the development of management information systems in postsecondary education. In addition to the NCHEMS information system products, a computer software package called HEPS (Higher Education Planning System) is also available which provides the same kinds of outputs as the NCHEMS software, as well as reports in areas not covered by NCHEMS. Based on an analysis of documentation and informal interviews with current users of both systems, this paper compares the basic approach of HEPS vs. NCHEMS, will outline some of the basic assumptions underlying the computer programs, compare representative data input requirements and output report formats, and discusses the basic alternatives available to administrators and technicians presented with the availability of two major higher education "MIS packages."

THE "PACKAGED" APPROACH TO MIS: HEPS vs. NCHEMS

Proponents of principles of "scientific management" and "rational policy analysis" seem to be appearing in increasing numbers in postsecondary education. While some administrators have acceded only reluctantly to the demands of regulating agencies for improved management practices at their institutions, others have come to believe that implementation of new management techniques will also provide substantial internal benefits that may be essential to survival in the long-run.

Within this context, an increasing number of different resource allocation and planning decisions are being perceived as requiring informational inputs of the type that can only be produced (in practical terms) from a computerized "management information system" or "MIS." In recent years, the postsecondary education field has been flooded with articles and papers describing the various attributes and uses of MIS technology. For purposes of this paper, the definition of MIS recently described by Service will be used, i.e., an MIS is the combination of people, processes and computer software that "integrates and transforms operational data into information useful in planning and management."[1]

There are a number of computer software "packages" currently available that might be used to assist in performing the function mentioned above. For example, Plourde has recently completed a survey which resulted in responses from individuals at 186 institutions which had acquired, tested or implemented at least one of four computerized analytical models, namely, CAMPUS, HELP/PLANTRAN, RRPM and SEARCH.[2] Within the framework of the Information Exchange Procedures Program (IEP) much effort has recently been devoted by the staff of the National Center for Higher Education Management Systems (NCHEMS) to dissemination of information concerning their Costing and Data Management System (CADMS). The CADMS package includes RRPM as one of seven basic "modules" which might be used in support of planning and management activities. In addition, a set of computer programs packaged under the title, "Higher Education Planning System" (HEPS) is being marketed successfully by a private firm, Education and Economic Systems, Inc. (EES).

For obvious reasons, no two of the software products mentioned above are strictly comparable; they were designed by different individuals with (to one extent or another) different purposes in mind, under differing assumptions, and for different institutional environments. However, significant overlapping exists, and descriptions of similarities and differences are of interest to persons responsible for the selection and implementation of analytical tools at specific institutions. This paper compares and contrasts NCHEMS/CADMS with HEPS, in an attempt to illuminate some of the major differences between them, and highlight those areas where they overlap to some extent.

Marketing Philosophy

At a very basic level of interest, there are several differences between CADMS and HEPS in the way they may be acquired and installed. Because NCHEMS has been largely supported by federal funds, its products are essentially in the "public domain." For this reason, the CADMS package is available to requesting individuals basically for the cost of reproduction. Furthermore, in some cases institutions are encouraged to acquire the computer programs by obtaining copies from other schools with identical computer hardware and CADMS successfully installed and tested. In the past, NCHEMS placed major emphasis on disseminating information about the potential uses of the outputs of its software products. More recently, increased attention has been turned toward some of the basic aspects of installation and implementation, as for example in the Costing and Data Management System Seminars which have been offered since last summer. Also, under certain circumstances it may be possible for schools to obtain on-site assistance from NCHEMS in the installation and implementation process.

HEPS, on the other hand, is strictly proprietary, and may only be obtained as the result of a purchase agreement with EES. As of this writing, the package may be obtained (whole or in part) for "self-installation" by in-house personnel, or on an "installed and tested" basis at an appropriate increase in cost. (There is also available a Spanish-language version of HEPS, and a scaled-down version for institutions with approximately 5,000 students or less, which does not require on-site processing capability.)[3] If acquired on a "self-installed" basis, EES representatives have stated that they provide software and documentation and a limited amount of technical assistance. The other basic option is to purchase the package (or one or more modules) "installed and tested" by EES. Arizona State University (ASU), acquired the total package under this type of agreement. After finalization of the contract, in-house staff provided code sets, definitions and report format specifications to EES. ASU personnel also constructed test files from existing institutional files. According to a pre-arranged schedule, these steps were followed by on-site installation and testing of the software (including education of systems support personnel) until a specified level of performance had been reached.

Both packages are similar in that they are "supported," in the sense that NCHEMS has distributed several recommended program code changes to known owners of CADMS, and it appears that EES personnel will "fix" non user-caused problems with program code that surface after the testing period. Users may make in-house changes to programs in both packages, but--for obvious reasons--this action voids any responsibility on the part of the developer (NCHEMS or EES) for subsequent problems that may arise. As of the time this was written, both systems appear to be relatively "static" in the sense that there appears to be no major effort on the part of either NCHEMS or EES to develop improved versions of the programs for future distribution to current owners.

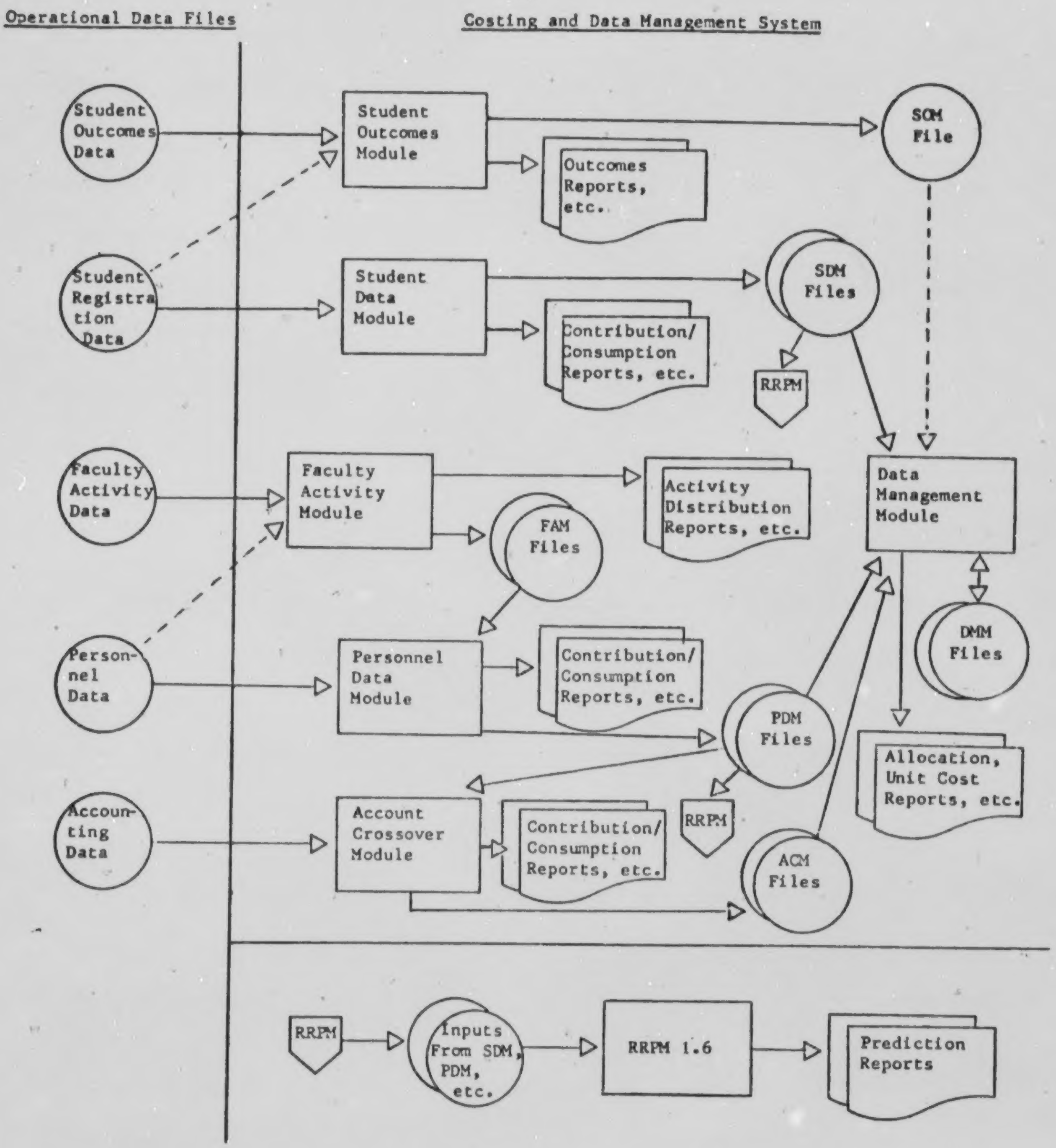
Basic Contents: NCHEMS/CADMS

Before a comparison of the two packages can be possible, it will be necessary to briefly summarize their contents. An overview of the NCHEMS/CADMS software has been provided by Haight and Martin in, "An Introduction to the NCHEMS Costing and Data Management System."[4] As described in this report, CADMS was put together to facilitate production of two basic kinds of cost information: historical, i.e., descriptive of costs incurred by activities already completed in a specified time period; and predictive, which estimates or projects costs of specified future activities under a given set of assumptions. As depicted in Figure 1, the CADMS structure is modular, and incorporates a number of possible interdependencies. The Data Management Module is the principal source of summarized historical cost information, while RRPM is the tool used to generate predictive cost studies; both require inputs from sources other than the operational data files of the institution, either from one or another of the other CADMS modules (as shown), through manually generated inputs, or from interface software developed in-house.

Although CADMS is being marketed as a tool for fulfilling the objectives of the Information Exchange Procedures program (which promotes exchange of historical cost information between schools), NCHEMS personnel are quick to point out that it was designed with sufficient flexibility to potentially serve a variety of in-house purposes. Furthermore, in addition to supplying necessary inputs to RRPM and the Data Management Module, the remaining five modules perform certain functions and produce certain reports that may or may

FIGURE 1

NCHEMS/CADMS BASIC SYSTEM STRUCTURE


Operational Data Files
Costing and Data Management System
Student Outcomes Data
Student Registration Data
Faculty Activity Data
Personnel Data
Accounting Data
Student Outcomes Module
Outcomes Reports, etc.
SOM File
Student Data Module
SDM Files
Contribution/ Consumption Reports, etc.
RRPM
Faculty Activity Module
Activity Distribution Reports, etc.
FAM Files
Data Management Module
DMM Files
Personnel Data Module
Contribution/ Consumption Reports, etc.
PDM Files
Allocation, Unit Cost Reports, etc.
Account Crossover Module
Contribution/ Consumption Reports, etc.
RRPM
ACM Files
RRPM
Inputs From SDM, PDM, etc.
RRPM 1.6
Prediction Reports

not be useful in and of themselves.

A point to remember for the later comparison with HEPS, is that although a variety of edits are performed on the data coming in to each module, CADMS does not include any provision for direct interface with institutional files. In other words, extracting, formating and sorting of the data from operational files must be accomplished through in-house program development.

A brief summary of each of the CADMS modules is provided below. Because of the complexities of the various modules and sub-systems these summaries could not possibly describe (in the space alloted) all characteristics or attributes of the software. Selected basic assumptions and features are presented to facilitate comparison with HEPS at a general level.

Summary of Individual Modules: NCHEMS/CADMS

Student Outcomes Module. The principle function of this module is to provide the capability to edit, store and display questionnaire responses collected from students using the NCHEMS "Student Outcomes Questionnaire for Program Completers." Optionally, questionnaire response data might also be linked with historical cost information by generating formatted records for input to the Data Management Module, although NCHEMS personnel frankly admit that the results would probably be of highly questionable validity or utility.

The Student Outcomes Module is the least flexible of the NCHEMS software products, although provision is made for processing of up to 20 responses to questions designed in-house. The only required inputs are data from the questionnaire; optionally the student's major and level may be obtained through a matching process using a student file as input. Basic outputs include an edit report and two summary reports displaying questionnaire responses sorted and arrayed in a variety of ways (e.g., by degree type, student level, etc.). A complete description of this module is found in the NCHEMS/WICHE Technical Report #61, "NCHEMS Costing and Data Management System Student Outcomes Module Reference Manual."

Student Data Module. This module was designed for the principal function of converting student registration data into summarized relationships between "disciplines" and majors, expressed either in terms of an induced workload matrix (IWLM) or induced course load matrix (ICLM). A typical IWLM might aggregate student credit hours generated by students of a particular level (freshman, sophomore, etc.) within each major, in courses (by level) across all disciplines in the university. The ICLM is constructed in the same way, but expresses the unit of output selected (credit hours, enrollments, etc.) in terms of averages. (Suslo has recently provided a more detailed description of the concept and use of an ICLM.)[5]

The Student Data Module also produces summarized enrollment statistics and formatted data inputs for RRPM, the Personnel Data Module and the Data Management Module. To produce a typical IWLM or ICLM the only required data elements would be student I.D., discipline of the course, course level, student major, student level, and credit hours generated; a variety of other elements might also be input, depending on the nature of the desired matrix. In addition to a file containing summarized enrollment data and IWLM records, the module produces a "Consumption Report" showing credit hours "consumed" by students (by level within major) from the various courses (by level) within each discipline, and a "Contribution Report" showing hours "contributed" by each discipline to students in particular majors. Complete reference information is found in NCHEMS/WICHE Technical Report #60, "NCHEMS Costing and Data Management System Student Data Module Reference Manual."

Faculty Activity Module. The principal function of this software is to provide the capability to edit, store and display data from faculty activity analysis questionnaires. The NCHEMS "Faculty Activity and Outcome Survey" may be used as a collection instrument, or the institution may define an instrument of its own. A high degree of flexibility was designed into the module to allow institutional definition of data elements, such as the various faculty "activities". In addition to faculty I.D. information and the average hours per week spent on the various faculty activities, funding account information is required to facilitate distribution of salary dollars to faculty activities on the basis of the "reported time spent." Basic outputs include a "Detailed Distribution Report" listing all activities by type and indicating the percent of an individual's time (and associated salary) devoted to each activity. A "Summary Distribution Report" aggregating the data for specified organizational units (e.g., college, department, etc.) is also produced, as well as formatted input records which can be passed to the Personnel Data Module. Complete reference information is found in the NCHEMS/WICHE Technical Report #58, "NCHEMS Costing and Data Management System Faculty Activity Module Reference Manual."

Personnel Data Module. This module was designed to relate "compensation paid" information to "activities performed", e.g., as reported on a faculty activity analysis questionnaire and processed through the Faculty Activity Module. The amount of compensation paid is distributed to the activities in proportion to the effort expended in each area. The design of this module is flexible to allow institutions to relate cost information to a variety of "outputs" such as courses taught, student credit hours produced, contact hours produced, or "hours of effort expended." The module produces three reports that document the processes and display the results of the calculations performed. Formatted inputs to RRPM and the Data Management Module may be produced as well as a file of "distribution percentages" (based on "contributed" and "received" activities over various course levels and between disciplines, departments, etc.) for forwarding to the Account Crossover Module. Four types of data elements are required for input ("person type, activity, DISC/ DEPT, course level") but each is institutionally defined, and might come from a variety of sources. Complete reference information is contained in NCHEMS/ WICHE Technical Report #59, "NCHEMS Costing and Data Management System Personnel Data Module Reference Manual."

Account Crossover Module. The principal function of this module is to "distribute" or "translate" dollar amounts (either budgeted or expended) from institutional account balances to a structure that will facilitate historical unit costing. For example, based on the "distribution percentages" forwarded from the Personnel Data Module, dollar amounts from various kinds of accounts (e.g., wages, travel, supplies, etc.) might be allocated to teaching activities by course level within each department. Input data may originate either from the Personnel Data Module, the institution's general ledger file, or may be input manually. In addition to formatted input records for the Data Management Module, a "Contribution Report," and a "Consumption Report" are produced which show the results of "crossing" the institutional account dollar amounts into the new structure (as defined by the institution). Complete reference information is found in NCHEMS/WICHE Technical Report #57, "NCHEMS Costing and Data Management System Account Crossover Module Reference Manual."

Data Management Module. This module was designed to provide the capability to create and maintain a file of stored values related to institutionally defined "cost centers" for costing purposes. In effect, the software creates a two dimensional matrix of values (such as credit hours, direct cost, indirect cost, enrollment, etc.) associated with individual cost centers such as "lower division biology, upper division biology, lower division chemistry," etc. Once the file has been created (from inputs generated by the Account Crossover Module, Personnel Data Module, Student Data Module, or from manual sources) values in the resulting matrix may be displayed in a variety of ways. Also, various kinds of arithmetic calculations may be made (e.g., converting quarter credit hours to semester credit hours) as well as transactions adjusting the basic values in the file. In each case, reports are generated which show the effect of the transactions applied to the file, and, since file processing is strictly sequential, back-up is provided through the generation of "father/son" files.

The module also produces two specialized reports which reflect the most probable uses of the stored data. One report is an "Allocation Report" which describes the proration of summary amounts to cost centers on some institutionally defined basis (typically, allocation of indirect costs to "primary activity centers" such as an academic department). The other specialized report is a "Unit Cost Report" which calculates and displays unit costs as defined by the institution; for example, calculation of cost per student credit hour, cost per level of instruction, etc. In all cases, the flexibility designed into the system allows the institution to define cost centers and units in whatever way seems appropriate at the time. Full reference information is found in NCHEMS/WICHE Technical Report #62, "NCHEMS Costing and Data Management System Data Management Module Reference Manual."

Resource Requirements Prediction Model (RRPM). This software has been available independent of CADMS for a number of years, but is included in the CADMS package as the simulation instrument for developing predictive cost information. As was noted in the discussion of the individual modules above, much of the input data required to run RRPM can be generated from the Student Data Module (i.e., ICLM data) and the Personnel Data Module. Based on historical cost information and the derived enrollment projections, RRPM produces reports that are intended to help administrators "bracket uncertainty" in the future. An "organizational budget," "program budget," and "institutional summary" are produced which project future costs in terms of support dollars and FTE faculty requirements. The module was designed with sufficient flexibility to allow institutional experimentation with a variety of bases for projecting costs, as well as testing the impact of assumptions regarding enrollment trends, etc. Projections may be based on cumulative iterations of the model beginning with data from a particular base year, or may be developed for future years using independent iterations. A more complete description is found in NCHEMS/WICHE Technical Report #34A, "Introduction to the Resource Requirements Prediction Model 1.6," and Technical Report #34B, "Resource Requirements Prediction Model 1.6 Reports."

Basic Contents: HEPS

The total HEPS package consists of fourteen "target modules" that produce reports in three areas (as defined by EES): (1) assessment reports, (2) budget reports, (3) simulation reports. Unlike NCHEMS, HEPS does provide the capability to create and maintain operational data files, as well as a small variable report writer and several utility routines for maintaining and displaying files. The complete system is "dictionary driven" in the sense that basic data element definitions and code sets are maintained in independent files which are accessed by the file maintenance and report writing programs.

The "Data Element Dictionary" and "Codes" files provide for standardization of data elements across all functional areas that support HEPS operational files. The package provides a relatively flexible means for creating and maintaining fixed length records in a hierarchical file structure.

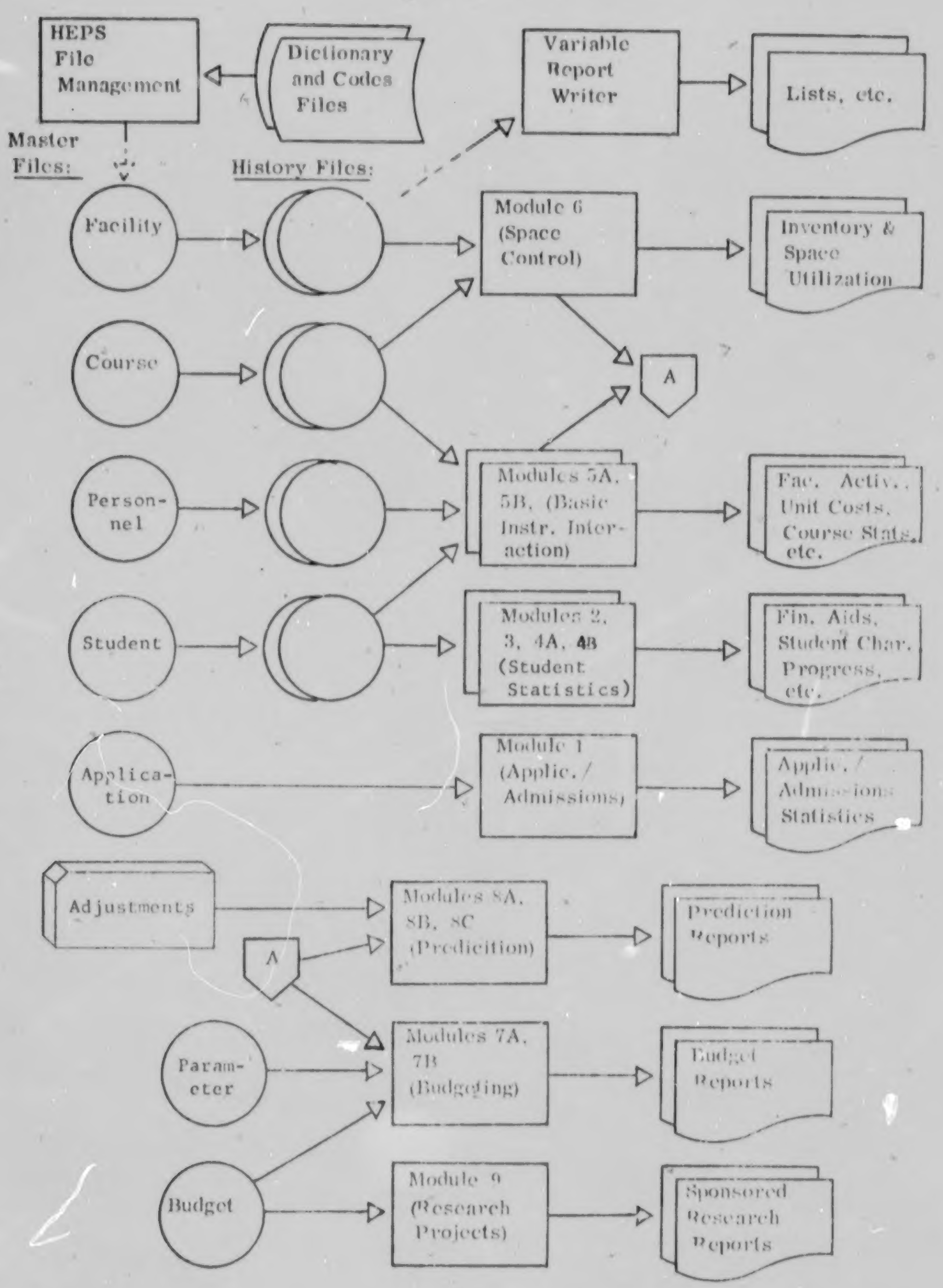
The flexibility and expandability of the HEPS file structure is somewhat offset by the fact that the fourteen "target modules" consist, in essence, of collections of "fixed format" report writers. In other words, provisions for fixed data element characteristics, report headings, and column headings are "hard-coded" into the report generating programs prior to installation. Therefore, subsequent changes to the HEPS reports (in basic content or format) require changes to program code. To offset this type of "rigidity," it appears that EES has attempted to provide a variety of report formats anticipating a large number of information requests. Also, a capability is provided ("Group-Opt") to permit the user to obtain any standard HEPS report produced for a particular group (e.g., students in biology), for any sub-group supported by the available data (e.g., in-state freshmen in biology).

Many of the so-called HEPS "assessment reports" provide information of the type commonly produced by existing systems on many medium to large campuses. HEPS personnel have stated that many of these reports would be of primary interest to an institution developing its initial capabilities in these areas (for example, at a newly organized community college). Each of the modules (as well as the file management software) may be purchased separately, which makes it possible to obtain only those report capabilities which are needed.

The basic configuration of HEPS is depicted in figure 2. The "master files" depicted are operational data files. If they are created and maintained using HEPS file management software then no special interfaces are required to produce the "snapshot" historical files from which most of the reports are generated. Otherwise, in-house interface programs must be written to extract and re-format data from institutional files.

Information on HEPS is available in a variety of promotional and reference

FIGURE 2
HIGHER EDUCATION PLANNING
SYSTEM (HEPS)


HEPS File Management
Dictionary and Codes Files
Variable Report Writer
Lists, etc.
Master Files:
History Files:
Facility
Module 6 (Space Control)
Inventory & Space Utilization
Course
A
Personnel
Modules 5A, 5B, (Basic Instr. Interaction)
Fac. Activ., Unit Costs, Course Stats, etc.
Student
Modules 2, 3, 4A, 4B (Student Statistics)
Fin. Aids, Student Char. Progress, etc.
Application
Module 1 (Applic./ Admissions)
Applic./ Admissions Statistics
Adjustments
Modules 8A, 8B, 8C (Predicition)
Prediction Reports
A
Parameter
Modules 7A, 7B (Budgeting)
Budget Reports
Budget
Module 9 (Research Projects)
Sponsored Research Reports

documents from Education and Economic Systems, Inc. (Boulder, Colorado). As with the NCHEMS/CADMS materials, only a brief summary of selected major characteristics and outputs is provided here, for purposes of a general comparison.

Summary of Individual Modules: HEPS

Target Module 1: Application/Admissions. As its name indicates, this module provides information designed to assist in monitoring the flow of student applications and admissions. The report programs require data from an operational student file which retains application and admission information, which is not a routine practice at some schools. One report shows the number of applicants by type (e.g., first time freshman, transfer students, and graduate students) from specified geographical areas, and a summary of institution/applicant actions taken. The amount of detail desired in the geographic information is determined in-house, and may be changed after installation. Another report provides information concerning the secondary schools attended by first time freshmen, while a third report displays origin information for transfer students.

Target Module 2: Financial Aids. The Financial Aids module provides a method of monitoring various kinds of actions taken in the financial aids program. One report in this statistical series shows the dollar amounts recommended for each applicant and the amount actually awarded by type (e.g., grant, loan, workstudy, etc.). The report requires input from a HEPS student history file in which this type of financial aid information is maintained. The module also produces a report summarizing the number of awards, total amounts, and average amounts awarded by type and source. Another set of reports displays information regarding students applied, admitted, and registered, distinguishing between those students awarded full amounts as opposed to those who received a partial amount, were denied, or did not request aid.

Target Module 3: Student Characteristics. The report series in this module provides basic student data for the current year, as compared to two previous years, for both full and part time students. Each report may be produced by student level and student admission type and gives breakdowns for male and female. Reports include profiles of student enrollments by age, ethnic origin, type of enrollment (new freshman, transfer, etc.), geographic origin, rank in high school graduating class, relative ranking on entrance test scores, and student major. Input from a HEPS student history file containing appropriate data elements is required.

Target Module 4A (Student Progress): Retention/Progression. The basic source of data is a HEPS student history file, and collection of appropriate data elements is assumed. The reports in the retention/progression series provide statistics regarding student progress through changes in majors, transfers, dropping out, etc.

Target Module 4B (Student Progress): Grades. Drawing from a HEPS student history file with grades posted, the grades series of reports shows distribution of current grades by level (undergraduate students, graduate students, etc.) and current GPA or cumulative GPA for students by sex, major and college.

Target Module 5A: Basic Instructional Interaction. The reports in this series require data from the HEPS course, student and personnel history files, and assumes collection of data elements such as "instructor contact hours", and "type of instruction" (for course sections) which may not be routinely collected at some schools. The module generates data to drive several of the budgeting and simulation modules described below, as well as 39 different report formats displaying a variety of potentially useful information.

Some of the reports in this series include: faculty contact hours by type of instruction, listed for each individual faculty member and comparing the current year with the previous two years; faculty contact hours by type of instruction by rank within college (summary report); faculty cost per course, credit hour and contact hour; student credit hours generated by student level within course level; an "Instructional Profile" report which divides faculty contact hours by course credit; and, reports dealing with class size and the production of student credit hours by rank of faculty. Other reports within this module depend on data of the type collected from a faculty activity survey, and display distribution of faculty time (and associated salary) among the faculty member's various activities (teaching, administration, counseling, etc.). Another series of programs establishes the basis for course costs by linking course information with instructor salary and activity information to derive cost per course credit hour and contact hour.

Obviously the discussion here only touches upon the many functions and complexities of this module, although it should be apparent that the contact hour concept is relatively important in HEPS. A standard feature of these reports is that, where appropriate, data for the current year is compared to the preceding two years. Probably the most important report in this series is a report which reflects the computation of "FTE faculty required for instruction." FTE faculty in this case is defined on the basis of a full instructional load for one individual for one semester (e.g., 12 contact hours per semester). Basically, the HEPS algorithm determines FTE instructional faculty required by relating student credit hours, faculty contact hours, course credit, section size, and the institutional standard for faculty teaching load, to determine hypothetical requirements for: individual courses, courses of a particular level, or an entire instructional program, department, college or university.

Target Module 5B: Enriched Instructional Interaction. Reports in this series deal with distribution of faculty members by rank across departments, amounts of faculty time (by rank) devoted to teaching at the various levels, FTE faculty instructional effort by level, amounts of time (and associated dollars) "contributed" by faculty members to departments other than their own, and a summary of courses taught in the current term showing type of amount and credit, maximum minimum size and current enrollments. Data elements required to produce these reports are the same as for Target Module 5A.

Target Module 6: Space Control. The reports produced by this module display information on the condition of buildings, number and sizes of rooms, comparisons of actual utilization with institutional targets, and depiction of times (by hour and day) of heavy and light room use. One of the reports from this module is simply an inventory of space (rooms) by size and type of use, etc. The data for these reports come from the HEPS physical facilities inventory file, and the course file (for space utilization statistics).

Target Module 7A: Budgeting for Faculty. This module requires information generated from module 5A (Basic Instructional Interaction). From the inputs provided, a "parameter file" is constructed which includes student credit hours by subject, field and level, student contact hours divided by course credit, class size, teaching hours per FTE faculty (defined in terms of a full contact hour load) distribution of student credit hours by rank, and faculty salary by rank. A "gaming process" is employed to allow the budget administrator to enter desired changes in any of the parameters and then to examine the effects of those changes in subsequent reports. The reports produced display FTE faculty and dollars required for instruction, FTE faculty and dollars required for all functions, and an appropriate summary.

Target Module 7B: Full Budgeting. Unlike module 7B, which facilitates budget "gaming" for faculty only, this module supports a full budgeting system for the institution. In addition to the basic inputs required for modules 5A and 7A, this module also requires data from the personnel file and the institution's budget file. For a more detailed account of the HEPS budgeting process and philosophy, interested persons may wish to obtain the "Administrative Handbook No. 2, Budgeting in HEPS," and, "Budgeting and Simulation in HEPS: A Brief Case Study," Education and Economic Systems, Inc. Twenty-eight different report formats are generated by this module in the process of creating a "parameter generated budget", a "fine-tuned budget", and an actual "adopted" operating budget, as well as a monthly "comparison of actual to budgeted expenditures" report.

Target Module 8A: Basic Simulation. This is one of three modules involving simulation in HEPS. This module produces only one report, a projection of student credit hours by field and level. This module is also known as HEPS subsystem SCALE (Student-Credit-Adjustment-Load-Entity), and will run from data selected from a HEPS-maintained student history file, or data in HEPS student history file format (stand-alone version).

If installed as a stand-alone system, SCALE requires input of the year of first registration, and type of registration (transfer, first time freshman, etc.) for each student, and a record of which students registered in which subject fields (by level) for the current term and for either one or two terms immediately preceding. The input of other kinds of student information (sex, ethnic origin, entrance test score, etc.) will expand the basic capabilities for simulation. Using a "weighted slope averaging technique" (more recent data is weighted more heavily than older data) SCALE projects student credit hours and displays them in the form of a matrix with "years in the future" as column headings, and subject fields (divided into levels) as row headings. Institutional judgements can be entered to modify the result by adjusting parameters in four areas: changes in the popularity of various student majors, changes in the course patterns taken by various student subgroups, changes in the attrition rate, and changes in the length of time taken to complete. More detailed information concerning SCALE is provided in the "Administrative Handbook No. 3, Simulation in HEPS," from Education and Economic Systems, Inc.

Target Module 8B: Simulation/Faculty Predictor. Based on the output from module 8A (or an optional parameter file) this module calculates a projected budget for FTE faculty and dollars for instruction, FTE faculty and dollars for all functions, and a summary report that reflects several fiscal years at the same time. Three reports are produced in the same format as the reports generated from Module 7A (Budgeting for Faculty).

Target Module 8C: Total Resource Predictor. To produce the reports from this module, the institution must have installed modules 3, 5A, 6 and 8A (see descriptions above). Assuming all of the data element requirements for those four modules have been met, this module provides the capability to project future budget requirements for dollars and personnel other than faculty, short and long range space projection requirements, and future amounts projected for supplies, equipment and other expenses. Various parameters are established by the institution as the basis for projections in each area. A total of 16 report formats are produced in this report series.

Target Module 9: Research. From specialized data stored in a HEPS budget file, this module produces reports in 6 formats that display data concerning sponsored research projects at the individual project level, discipline level, department, division, school (or "college") and institution. The basic report format includes general information (beginning date, ending date, etc.) sponsor information by name and type and amount, the names of participants involved, and a listing of any research-related equipment purchased costing more than a specified amount (e.g., $10,000).

Comparisons: CADMS vs. HEPS

A basic comparison between CADMS and HEPS based on differences and similarities in the type of outputs produced is summarized in Figure 3. It is clear that CADMS and HEPS produce outputs in several areas that are clearly exclusive. For example, CADMS was not designed to produce statistical reports of the type outlined in items one through eight of Figure 3. On the other hand, HEPS does not provide the capability to collect and process the type of "student outcomes" information alluded to in item 17.

In a few areas, the outputs of the two systems may be directly compared because they attempt to show similar kinds of relationships, as in the case of item 10, "Faculty Activity Data." A comparison of a sample HEPS Report No. 13-01-A, "Time and Dollar Allocations," (Figure 4), with a sample NCHEMS Report No. FAM-02, "Faculty Activity Module Detailed Activities Distribution Report," (Figure 5), illustrates some of the basic differences in focus and philosophy between the two systems. In this case, the HEPS report reflects a pre-defined structure of 15 activity types (identified prior to installation) with corresponding "hard-coded" column headings. Also, note that the amounts of time reported as being devoted to the various activities is expressed in terms of a proportion of "full instructional load," defined here as 12 "contact hours." The format of this report results in a number of individuals in a department appearing on each page, with the salary dollars for each

FIGURE 3
COMPARISONS

Type Of Output	HEPS	NCHEMS
1. Applications/ Admissions Statis.	Target Module 1	
2. Fin. Aids Statistics	Target Module 2	
3. Student Charact. (Stat. Profiles)	Target Module 3	
4. Student Retention/ Progression Statis.	Target Module 4A	
5. Student Grade Statistics	Target Module 4B	
6. Course Offering Statistics	Target Module 5B	
7. Facil. Inv. & Space Utilization	Target Module 6	
8. Research Projects (monitoring)	Target Module 9	
9. Budgeting: for Faculty Only Full	 Target Module 7A Target Module 7B	
10. Faculty Activity Data	Target Modules 5A & 5B	Faculty Activity Module
11. Relating Faculty Compen. to Activ.	Target Modules 5A & 5B	Faculty Activity And Personnel Data Modules
12. Unit Costing (Historical)	Target Module 5A	Data Management Module
13. Simulation:		
Predicting Faculty Requirements, Costs & Support Costs	(Target Module 5A) Target Module 8B	RRPM1.6
Predicting SCH Generation	Target Module 8A	
Predicting Space & Other Resource Requirements	Target Module 8C	
14. Alloc. of Costs to Instit. Cost Ctrs. (Historical)	(Target Module 5A?)	Data Management Module
15. Contrib./Consump. between depts.		Student Data Module (IWLM, ICLM, etc.)
16. Prorating, "Transf." or Adj. Gen. Acct. Dollars		Account Crossover
17. Student Outcomes		Student Outcomes

```
HIGHER EDUCATION PLANNING SYSTEM                           TIME AND DOLLAR ALLOCATIONS                                          PAGE     33
INSTITUTION   ARIZONA STATE UNIVERSITY               FACULTY-PROFESSIONAL - BY FUNCTION                                         RPT 13-01-A
CAMPUS/VP     ASU - TEMPE                                                                                                       1976-FALL SEMESTER
COLLEGE                                                                                                                         09-15-76
DEPARTMENT

      FULL INSTRUCTIONAL LOAD   =  12.00
      **** INDICATES HOURS NOT  =  12.00
      ---- INDICATES NOT INCLUDED IN TOTAL OR AVERAGE
                                  INSTRUCTION & DEPT RESEARCH                               SCH/
                         TOTAL           ADVIS-     C&C   UNIV      SPON     IND  GRANTS    PERS      STU     COM     ADM      PUR     OTH             OTHER
       SSN - NAME      HRS/DOLS    TCHG   ING       DEV   ASGNES    RES      RES   PREP     DEV       SVC     ASG     DUT      SVC     ASG   OTHER     DEPTS

ASSISTANT PROFESSOR

****                       3.00    3.00
                            450     450

****                       1.00    1.00
                            450     450

****                      18.00   18.00
                          6,000   6,000

                          12.00    9.00                                      1.00                             1.00     1.00
                          6,822   5,118                                       568                              568      568

                          12.00   11.00                                      1.00
                          6,374   5,643                                       531

****                      15.00   16.00
                          7,560   7,560

****                      16.00   15.00
                          6,750   6,750

     SUBTOTAL            310.00                                              9.00                             1.00
                        120,879                                             5,521                              568
                                 287.00                                                                              13.00
                                110,771                                                                              4,019
```

FIGURE 4

```
RUN = SAMPLE                               FACULTY ACTIVITY [illegible]                                   JAN 1975
INSTITUTION = ALL                      DETAILED ACTIVITIES DISTRIBUTION REPORT

(ADM ) ADMIN DEPT         FACULTY INFORMATION
                              FACULTY RANK = NONE                     TENURE = NONE                  YEARS AT INST =    8
   RICHARDS DAVID             ADMINISTRATIVE RANK = DIR  DIRECTOR                                    YEARS IN RANK = NONE
         452502722            LENGTH OF APPOINTMENT =  12.0           TERM = AY ACADEMIC YEAR

      FUND SOURCE                                  FISC REF   FTE      SALARY  ORGANIZATIONAL UNIT                PCS CODE

      440.1             INSTRUCTION                  I         .25     3,427.  (ADM ) ADMIN DEPT                   111500
      410.1             LIBRARY                      A         .85    13,151.  (ADM ) ADMIN DEPT                   410000
                                                           -------- ----------
                                                              1.10    16,578.

    ORGANIZATIONAL UNIT   COURSE/  FISCAL   REPORTED  PERCENT OF TOTAL  DISTRIBUTED  CONTACT  CREDIT CREDIT X  SECTION
                          SECTION  REF CODE   TIME     REPORTED TIME      SALARY      HOURS   HOURS  ENROLLMENT CODE

  A1   SCHEDULED TEACHING
    PHIL-PHILOSOPHY       110 -01     I         .70          1.20            110.      5.00    3.00       81.
    PHIL-PHILOSOPHY       213 -01     I        5.00          8.61            786.      3.00    3.00       81.
    PHIL-PHILOSOPHY       223 -01     I        5.00          8.61            786.      3.00    3.00       42.
                                              --------     --------       ----------  ---------------  -------
    * ORGANIZATIONAL UNIT TOTAL               10.70         18.43          1,682.     11.00    9.00      204.
  A3   ACD PROG ADV
    D     UNDERGRADUATE               I         .50           .86             78.
  A4   COUR & CURR DEV
    B     LOWER DIVISION              I         .50           .86             78.
    B     LOWER DIVISION              I         .50           .86             78.
                                              --------     --------       ----------
    ** TOTAL COUR & CURR DEV                   1.00          1.72            156.
  B2   GEN SCHOLARSHIP
    **** NO LEVEL                     A         .50           .86            181.
    **** NO LEVEL                     A        1.00          1.72            362.
    **** NO LEVEL                     A        4.50          7.75          1,632.
    **** NO LEVEL                     I         .50           .86             78.
    **** NO LEVEL                     I        4.50          7.75            707.
    **** NO LEVEL                     I        1.00          1.72            157.
                                              --------     --------       ----------
    ** TOTAL GEN SCHOLARSHIP                  12.00         20.67          3,117.
  C1   STUDENT SERV
    **** NO LEVEL                     I         .50           .86             78.
    **** NO LEVEL                     I         .10           .17             15.
                                              --------     --------       ----------
    ** TOTAL STUDENT SERV                       .60          1.03             93.
  C2   ADMIN DUTIES
    **** NO LEVEL                     A       16.00         27.56          5,804.
    **** NO LEVEL                     A        2.00          3.44            725.
    **** NO LEVEL                     A        6.50         11.19          2,358.
    **** NO LEVEL                     A        5.50          9.47          1,995.
                                              --------     --------       ----------
    ** TOTAL ADMIN DUTIES                     30.00         51.67         10,882.
  C3   COMM PARTICIPAT
    **** NO LEVEL                     I         .25           .43             39.
    **** NO LEVEL                     I        1.00          1.72            157.
    **** NO LEVEL                     I        1.00          1.72            157.
                                              --------     --------       ----------
    ** TOTAL COMM PARTICIPAT                   2.25          3.87            353.
  D    PUBLIC SERVICE
```

FIGURE 5

individual prorated across the various activities on the basis of reported time.

In contrast, the NCHEMS report reproduced as Figure 5 displays the distribution of time to activities in terms of actual hours reported. The various row headings give some indication of the options available in terms of level of detail and types of activities which may be defined by the institution in a "parameter input" process. The format of this particular report may result in several pages being printed for each individual, depending on the number of different activities. Also, note that the individual's specific course load is printed, along with "contact hours," credit hours, and total student credit hours generated.

Comparisons between CADMS and HEPS in the "Unit Costing" and "Simulation" areas become much more difficult because of the complexities inherent in both systems, because of redundancies inherent in both systems, and because certain kinds of processes which are explicit in CADMS (e.g., ICLM production, and the "Account Crossover" process) appear to be implicitly handled in HEPS, and vice versa. Only a preliminary investigation of requirements and capabilities has been done to-date at ASU in these areas. However, a few generalizations of interest can be made.

For example, in the unit costing area, HEPS is designed to produce detail and summary reports within an institutionally defined (and, presumably adopted) framework which assumes the primal utility of certain kinds of cost information and specific report formats. CADMS, on the other hand, is defined to handle an almost infinite variety of cost relationships and, accordingly, its report formats are "non-specific" and would not be generally viewed as appropriate--or intended--for direct management consumption. To illustrate, compare Figure 6, a sample output from the HEPS 22-02 series,

```
HIGHER EDUCATION PLANNING SYSTEM              FACULTY SALARY COSTS PER COURSE                                PAGE     3
ARIZONA STATE UNIVERSITY                                                                                     RPT 22-02
CAMPUS          ASU - TEMPE                                                                                  FALL SEMESTER
COLLEGE                                                                                                      09/15/76
DEPARTMENT
DISCIPLINE

                                                 COURSE COST                COST PER STUDENT              COST PER
                                                                              CREDIT HOUR               CONTACT HOUR
              COURSE    SECTION          1973       1974       1975      1973     1974     1975      1973    1974    1975

UPPER DIVISION

               301
                           A                                   4,589                      50.99                     1,311
                           B                                   3,379                      51.20                       965
                           C                                   2,304                      45.18                       650
                           D                                   2,407                      29.61                       710
                           E                                   2,467                      34.59                       710
TOTAL COURSE                                                  15,246                      42.00                       871

               412
                           A                                   4,572                      50.80                     3,098
TOTAL COURSE                                                   4,572                      50.80                     3,098

               420
                           A                                   4,917                      52.87                     1,311
                           B                                   3,621                      52.48                       965
                           C                                   2,468                      48.39                       658
TOTAL COURSE                                                  11,006                      51.67                       978

               450
                           A                                  10,135                     116.49                    33,783
                           B                                     914                      16.93                     3,096
TOTAL COURSE                                                  11,049                      78.36                    18,416

               499
                           A                                     808                     269.33                     1,616
TOTAL COURSE                                                     808                     269.33                     1,616

TOTAL UPPER DIVISION                                          42,681                      52.69                     1,341


GRADUATE OR PROFESSIONAL

               515
                           A                                   4,038                      58.52                     1,615
TOTAL COURSE                                                   4,038                      58.52                     1,615
```

FIGURE 6

"Faculty Salary Costs per Course, Student Credit Hour, and Contact Hour," with Figure 7, a sample page from the NCHEMS DMM-07, "Program Unit Cost Report." In practical terms, the difference outlined here may be of considerable importance in some circumstances. For example, an instructional cost study was recently mandated by the Arizona State Board of Regents for completion by the state universities. Because of the particular underlying philosophy and report format required by the Board, it appears that HEPS will be of no use in meeting the requirement. However, CADMS might be of assistance in performing some of the necessary prorations and allocations because of its inherent flexibility.

In the area of simulation (cost and resource prediction) the same kind of generalization described above for unit costing seems to apply. While a similar function is purportedly served by both packages, HEPS requires the existence of HEPS-compatible data, and a HEPS-supported institutional philosophy (except, perhaps, in the case of stand-alone use of Module 8A). RRPM, on the other hand, was designed in the hope of providing adaptability to a variety of institutional settings and uses. Although an intriguing capability in HEPS simulation which is clearly lacking in CADMS is the prediction of physical space requirements.

Conclusion

From the foregoing discussion, it should be apparent that the two software products discussed here differ greatly in terms of scope, input requirements, quantity and type of output report formats, basic philosophy and intended use. At the same time, there is a more or less clearly identified area where the two products overlap in proposed function, if not in specific method.

```
CPM-07                            N C H E M S   A T   W I C H E                                        PAGE   4
C00003.00                           PROGRAM UNIT COST REPORT                                           01-01-75

                    PROGRAM     DISCIPLINE         DIR.COST/CR         CREDIT.HOURS          DIRECT.COST

                                1.1.0306.20            36.9511               9.0000             332.5599
                                1.1.0420.20            62.2222               9.0000             559.9998
                                1.1.0801.20             5.0909              45.0000             229.0905
                                1.1.0801.30             5.5960               9.0000              50.3640

                 PPG.0801.LD    **TOTALS**             16.9547              99.0000           1,678.5126

                 PPG.0801.MA    1.1.0101.20             8.9365               9.0000              80.4285
                                1.1.0101.30            15.8333               9.0000             142.4997
                                1.1.0101.50            21.7779               9.0000             196.0002
                                1.1.0203.20            13.2125               9.0000             118.9125
                                1.1.0203.30            29.8919               9.0000             269.0271
                                1.1.0203.50            25.7670               9.0000             231.9030
                                1.1.0301.20            21.6667              18.0000             390.0006
                                1.1.0301.30            21.5741               9.0000             194.1669
                                1.1.0301.50            43.5185               9.0000             391.6665
                                1.1.0306.20            36.9511               9.0000             332.5599
                                1.1.0306.30            41.5806               9.0000             374.2254
                                1.1.0306.50            71.9259               9.0000             647.3331
                                1.1.0420.20            62.2222               9.0000             559.9998
                                1.1.0420.30           158.5556               9.0000           1,427.0004
                                1.1.0420.50           255.6296               9.0000           2,300.6664
                                1.1.0422.20            11.0000               9.0000              99.0000
                                1.1.0422.30             9.8889               9.0000              89.0001
                                1.1.0422.50            13.4444               9.0000             120.9996
                                1.1.0511.20            20.7037               9.0000             186.3333
                                1.1.0511.30            32.0278               9.0000             288.2502
                                1.1.0511.50            36.8333               9.0000             331.4997
                                1.1.0512.20            10.3778              18.0000             186.8004
                                1.1.0512.30            23.4444               9.0000             210.9996
                                1.1.0512.50            33.1481               9.0000             298.3329
                                1.1.0703.20            18.7500               9.0000             168.7500
                                1.1.0703.30            28.7037               9.0000             258.3333
                                1.1.0703.50            48.0952               9.0000             432.8568
                                1.1.0705.20           101.0000               9.0000             909.0000
                                1.1.0705.30           101.0000               9.0000             909.0000
                                1.1.0705.50           102.6667               9.0000             924.0003
                                1.1.0801.20             5.0909               9.0000              45.8181
                                1.1.0801.30             5.5960              18.0000             100.7280
                                1.1.0801.50            19.0185              27.0000             513.4995

                 PPG.0801.MA    **TOTALS**             40.1450             342.0000          13,729.5918

                 PPG.0801.UD    1.1.0703.20            18.7500               9.0000             168.7500
                                1.1.0705.20           101.0000               9.0000             909.0000
                                1.1.0801.20             5.0909               9.0000              45.8181
                                1.1.0801.30             5.5960              45.0000             251.8200

                 PPG.0801.UD    **TOTALS**             19.1026              72.0000           1,375.3881

                 FINAL TOTALS                          35.3770           1,611.0000          56,992.3137
```

FIGURE 7

Informal telephone interviews with a number of HEPS users has led to the conclusion that few, if any, institutions might expect to effectively use all of HEPS varied data handling and report writing capabilities; a general recommendation would seem to be "examine your needs carefully," to determine those specific areas where HEPS might be of most benefit. This would seem particularly true in view of the fact that the HEPS report generating programs appear to be no more or less flexible in terms of specific content and format--once installed--than applications programs developed in-house, and would be no more or less easy to replace or modify. At the same time, assuming general institutional acceptance of the style, content and philosophy of HEPS reports, adoption of the HEPS file maintenance and reporting system might lead to significant gains in data element standardization and improvements in reporting procedures.

A commonly voiced complaint against NCHEMS products is that they generally do not produce simple, easy-to-read reports for immediate management consumption. On the other hand, this has never been the principal focus or intent of the NCHEMS software development effort. In attempting to provide programs which are readily adaptable to a variety of different environments and specific uses, NCHEMS has sacrificed the kind of reporting simplicity that might result from a more narrow approach. As with HEPS, probably few, if any, schools will find all parts of CADMS useful or desirable. However, because of its relative low cost and built-in flexibility, many institutions may find it worthwhile to experiment in certain areas with the NCHEMS approach before proceeding to more expensive alternatives.

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[3] "Budgeting and Simulation in HEPS; A Brief Case Study" (Boulder, Colorado: Education and Economic Systems, Inc.), p. 2.

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A MULTI-USE AUTOMATED AFFIRMATIVE ACTION DATA RETRIEVAL AND ANALYSIS SYSTEM

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While many higher education institutions now have some form of computerized data retrieval system to provide needed affirmative action data, the question has now turned from "Do you have a system?" to "Is your system maximally efficient and economical?" It is now time to think of a data retrieval and analysis system that will meet entire university personnel needs. The University of Massachusetts affirmative action integrated data system achieves a level of efficiency and economy through the multiplicity of purposes it serves in addition to the affirmative action personnel needs. This paper provides a description of the planning and analysis of such a program, as well as a serious discussion of primary and secondary program benefits.

A MULTI-USE AUTOMATED AFFIRMATIVE ACTION DATA RETRIEVAL AND ANALYSIS SYSTEM

Introduction

Today, one almost guaranteed way to strike fear into the hearts and minds of college personnel officers and high level administrators is to bring up the topic of affirmative action. Just the mere mentioning of the term typically conjures up nightmarish visions of hiring statistics, compliance plans, self-study and progress reports, personnel grievance interrogatories, and law suits--data requirements! Even the casual observer in academe is aware that the generation of a range of personnel data to meet equal opportunity guidelines is becoming an increasingly significant activity in institutions of higher learning. You might say that the data appetite of affirmative action has progressed from childhood to adolescence. The once limited federal data requirements have become a voluminous maze of state and federal requirements expanding in several directions at one time. Title IX, Revised Order 4, EEO-6, Executive Order 11246, Title VI & VII, etc. have become common in the jargon of college administrators. This increase in breadth has been accompanied by a comparable increase in the depth of the data requirements. Specifically, governmental agencies responsible for the enforcement of affirmative action have spun out of their earlier phase of confusion and are quickly developing the capacity to translate the regulations into sophisticated data specifications. In turn, this dynamic has resulted in frequent changes in the data requirement specifications coupled with multiple timetables and reporting deadlines. In summary, affirmative action compliance now requires more data, for more agencies, in more forms, for more protected groups at greater frequency.

It is obvious from what has been stated thus far that any serious attempt by colleges and universities to meet federal and state affirmative action data requirements, as well as to provide data for their own equal opportunity planning and programming will best be supported by an integrated data system--a system which skins several data birds with one program. With the increasing complexity of the affirmative action mandate, it is important for institutions to act now to develop data retrieval and analysis systems which address anticipated future, as well as current, data needs. In effect, the system should transform what government has made complex into data that is simple to comprehend and clear in its application to planning.

> *"When thought is too weak to be simply expressed it is clear proof that it should be rejected."*
>
> *Marquis de Vauvenargues*

Perhaps the most impelling rationale supporting the implementation of a comprehensive affirmative action data system is to provide colleges with more time to take action steps to improve equal opportunity. Currently, far too many higher learning institutions find themselves in a situation where such a large reservoir of staff time is invested in data generation (summary and analytical), that little time is left for the planning and actual implementation of changes necessary to improve the institution's performance in providing equal employment and educational opportunities. Robert V. Goode, speaking of affirmative action in a paper presented at the 1975 CAUSE National Conference, urged university administrators to "manage it now". We would add to this suggestion that an efficient data base system is requisite to effective management.

The purpose of this paper is to present a brief discussion and description of the University of Massachusetts affirmative action data retrieval and analysis system whose very basic and simple design requires limited explanation. The system is diverse in its applications and features the following general program characteristics:

1. Data are easily comprehended by users
2. Data base is easily modified and/or expanded
3. Data update is optimally timely

An Integrated Data Based System

While the basic design of the University of Massachusetts affirmative action data base system consumed approximately 60-75 person days (1 person/FTE) development time, refinement of the system has evolved over a two-and-a half year period starting in FY 1974. Like most universities, the impetus for building the system was the need to meet pending federal EEO-6 reporting requirements. This report merely requests basic statistics relative to the employment status of minorities and women. However, since limited information was available from HEW during FY 1974 concerning the data specifications for the EEO-6 Report, a decision was made to develop a data system which anticipated a broad range of data specification possibilities.

The Program Master List Key (Figure 1) shows the breadth of the program data elements. In addition to the EEO-6 data requirements, the program displays data such as position title, education level, civil service rank, contract length, and leave information. The inclusion of both the employee and position number elements enhances the capacity for high data base integrity. Of course, how the data is reported (layout) is just as important as what data is presented. Accordingly, a layout has been designed which maximizes data

FIGURE 1

Program Master Key List

Organizational Unit:	51	30	10	5999
	↓	↓	↓	↓
	Amherst Campus	Student Affairs	MBU	Department

EMPNO	NAME	POSIT TITLE CD	R/C/S STP/EDUC
Employee Number		Position Number Title Code	Race/Citizenship/Sex Step/Education

Race Code

A = American Indian
B = Black
C = Asian
D = Spanish Surname
E = Caucasian

G = Other
H = Did not wish to report

Citizenship Code

Y = American Citizen
N = Not American Citizen

Sex

M = Male
F = Female

Step

(classified employees only)

Education Code

0 = Not coded
1 = No high school diploma--11 years of school or less
2 = High school diploma--12 to 13 years
3 = Associate's Degree or equivalent--14 to 15 years
4 = Bachelor's Degree
5 = Master's Degree
6 = Master's Degree Terminal
7 = Doctorate Degree
8 = Post Doctoral

FIGURE 1 (continued)

Program Master Key List

TITLE DESCRIPTION WORKING TITLE	SALARY/WEEK ANNUAL	APPT FIRST/LAST LNTH-YRS NEXT	LV DATE	TIME	FS	JOB CLASS
A = 12 month appointment		9 14 69 9 14 74 hire date last reappointment date	Leave Date	1.00 = full time	Funding Source	Classified
			Leave Code	.50 = half time	01 02 03 FD OT	60 = Office/Clerical 70 = Paraprofessional/ Technical 80 = Maintenance 90 = Skilled Craftsmen

L = Leave
S = Sabbatical
M = Military
T = Termination

*Non-Academic Professionals

5	4	9 14 78
years eligible for at next reappointment date	years of present contract	next reappointment date or end of current contract for anyone on a non-multi-year contract

*Faculty

TDY	2 78 79
Tenure Decision Year	2nd Semester 1978-1979

TEN

Tenure

Professional

	Title	Function
10	Staff Administrator with tenured faculty status in an academic department	
20	Staff Administrator	Staff
30	Staff Associate	Staff
40	Staff Assistant	Staff
50	Titled	Staff
21	Staff Administrator	Administrator
31	Staff Associate	Administrator
41	Staff Assistant	Administrator
51	Titled	Administrator

Faculty

Codes 1 through 6

1 Professor
2 Associate Professor
3 Assistant Professor
4 Lecturer
5 Instructor
6 Academic Coordinator

presentation, while minimizing user comprehension problems (Figure 2a and Figure 2b). Our experience has been that once given the Master List Key, users have experienced little or no difficulty in clearly understanding the Master List.

Again, the comprehensive yet basic design of the Program Master List is characteristic of the hardware and software requirements which in turn result in a simple but streamlined integrated data base system design (Figure 3). The fact that the implementation of the University's affirmative action data system required no new additions to its basic hardware and software package is one of its strongest selling points. The hardware installation at the University of Massachusetts consists of an IBM 370/155 utilizing a DOS/VS operating system and time sharing facilities. The software consists of an ANS COBOL program (generation of basic reports) and the Data Analyzer Retrieval Package (DART - generation of analytical reports).

While there are many important features in the system design, perhaps the most important is that the system data base is linked to both the Personnel and Position Master Files. These two files comprise the core data base for the University's overall DBMS. The benefits of this integrated common data base are obvious. Another system feature worthwhile commenting on is the option to generate two different types of reports. Users may request an individual listing (Master List) or analytical tables (DART Statistics). The DART option also allows for almost unlimited addition of new analytical tables. Likewise, the Master List is designed to allow for reasonable expansion. The selection criteria utilized in requesting both report types are shown in Figure 4. A future option of the program will involve the generation of prediction tables.

FIGURE 2a

```
DATE RUN 02/24/76                          UNIVERSITY OF MASSACHUSETTS                                      PER3280
                                             AFFIRMATIVE ACTION                                             PAGE: 199
ORGANIZATION UNIT: 71 22 10 1702  MATHEMATICS II
-------------------------------------------------------------------------------------------------------------------------
                                    POSIT      R/C/S    TITLE DESCRIPTION               WEEKLY SALARY FIRST APPT  LAST      LV TIME   FS   JOB
 EMPNO          NAME                TITLE CD  STP/EDUC  WORKING TITLE                   ANNUAL SALARY LNTH-YRS    NEXT      DATE           CLASS
-------------------------------------------------------------------------------------------------------------------------
 00587  G    . K                    52000548   E Y F    PRINCIPAL CLERK                        178.90  5 15 66    9 03 67       1.00  01   060
                        CLASSIFIED  09557        7      SECRETARY                            9,302.80
-------------------------------------------------------------------------------------------------------------------------
 08487  B      E                    52000725   E Y M    PROFESSOR U OF M                       420.06  9 01 72    9 01 72       1.00  01   001
                        FACULTY      90077              PROFESSOR                           21,843.12 TEN
-------------------------------------------------------------------------------------------------------------------------
 27127  E      E                    52000436   E Y M    ASSOC PROFESSOR U OF M                 429.52  9 01 69    9 01 69       1.00  01   002
                        FACULTY      90028              ASSOCIATE PROFESSOR                 22,335.04 TEN
-------------------------------------------------------------------------------------------------------------------------
 32363  G       M.              ., JR 52000204 E Y M    PROFESSOR U OF M                       612.74  9 01 70    9 01 70       1.00  01   001
                        FACULTY      90077              PROFESSOR                           31,862.48 TEN
-------------------------------------------------------------------------------------------------------------------------
 35277  G       M                   52000392   E N M    ASST PROFESSOR U OF M                  295.11  9 01 68    9 01 68       1.00  01   003
                        FACULTY      90014              ASSISTANT PROFESSOR                 15,345.72 TEN
-------------------------------------------------------------------------------------------------------------------------
 56208  L      M                    52000656   E Y M    INSTRUCTOR U OF M                      230.84  7 25 71    7 25 71       1.00  01   005
                        FACULTY      90071              INSTRUCTOR                          12,003.68 TDY           74 75
-------------------------------------------------------------------------------------------------------------------------
 64566  M      V                    52001124   E Y M    ASST PROFESSOR U OF M                  256.13  9 01 73    9 01 73       1.00  01   003
                        FACULTY      90014              ASST PROF                           13,318.76 TDY         1 78 79
-------------------------------------------------------------------------------------------------------------------------
 71444  P       S                   52000253   E Y M    ASSOC PROFESSOR U OF M                 396.23  9 01 67    9 01 67  L    1.00  01   002
                        FACULTY      90028              ASSOC PROF                          20,603.96 TEN                 8 31 76
-------------------------------------------------------------------------------------------------------------------------
 84003  S     G                     52000303   E Y M    PROFESSOR U OF M                       458.45  9 01 66    9 01 66       1.00  01   001
                        FACULTY      90077              PROFESSOR                           23,839.40 TEN
-------------------------------------------------------------------------------------------------------------------------
 85418  S                 ., H    , 52000210   E Y F    ASST PROFESSOR U OF M                  274.86  9 01 69    9 01 69       1.00  01   003
                        FACULTY      90014              ASSISTANT PROFESSOR                 14,292.72 TDY         1 75 76
-------------------------------------------------------------------------------------------------------------------------
 90886  T          T          .     52000263   C Y M    CHRMN. OF DEPARTMENT U OF M            645.30  8 01 65    9 01 65       1.00  01   010
                        FACULTY      90034              CHAIRMAN OF DEPT. & PROFESSOR       33,555.60 TEN
-------------------------------------------------------------------------------------------------------------------------
 92293  T    -    M           ,     52000215   E Y M    ASST PROFESSOR U OF M                  326.08  9 01 69    9 01 69       1.00  01   003
                        FACULTY      90014              ASSISTANT PROFESSOR                 16,956.16 TEN
-------------------------------------------------------------------------------------------------------------------------
 96673  W     . D                   52000367   E Y M    ASST PROFESSOR U OF M                  310.50  9 01 67    9 01 67       1.00  01   003
                        FACULTY      90014              ASSISTANT PROFESSOR                 16,146.00 TEN
-------------------------------------------------------------------------------------------------------------------------
                                  M    F                  A    B    C    D    E    F    G    H
** PROFESSIONAL **      * SEX *  011  001     * RACE *  000  000  001  000  011  000  000  000
                                  M    F                  A    B    C    D    E    F    G    H
** CLASSIFIED **        * SEX *  000  001     * RACE *  000  000  000  000  001  000  000  000
-------------------------------------------------------------------------------------------------------------------------
```

FIGURE 2b

```
DATE RUN 12/16/75                            UNIVERSITY OF MASSACHUSETTS                                    PER3280
                                               AFFIRMATIVE ACTION                                           PAGE: 741
ORGANIZATION UNIT: 51 30 20 5551  FINANCIAL AID OFFICE

                                 POSIT      R/C/S    TITLE DESCRIPTION                WEEKLY SALARY FIRST APPT  LAST      LV TIME  FS    JOB
     EMPNO          NAME         TITLE CD   STP/EDUC WORKING TITLE                    ANNUAL SALARY LNTH-YRS    NEXT      DATE         CLASS

     06358  B        A       ,   02000048    E Y F   JUNIOR CLERK AND TYPIST                117.70  8 13 74   8 13 74      1.00  01    060
                      CLASSIFIED 03520         2  3  SECRETARY                            6,120.40

     11150  B       C            18015650    B Y M   STAFF ASSOCIATE U OF M                 357.39 11 18 73  11 18 75      1.00  OT  * 030
                      STAFF      90085            4  ASSOC DIR OF FINAN AID SERV         18,584.28 2      1  11 18 76

     22573  D     R              02000763    E Y M   STAFF ADMINISTRATOR U OF M             428.87  8 12 73   8 12 75      1.00  01    021
                      STAFF      90083            8  STAFF ADMINISTRATOR (DIR. FIN.  22,301.24 3      1   8 12 76

     27315  E          C         02001967    E Y F   JUNIOR CLERK AND TYPIST                113.80  2 02 75   2 02 75      1.00  01    060
                      CLASSIFIED 03520         1  4  SECRETARY                            5,917.60

     40350  H          . G       02002251    E Y F   PRINCIPAL CLERK                        157.30 11 09 71  11 09 71      1.00  01    060
                      CLASSIFIED 09557         3  5  SECRETARY                            8,179.60

     56231  L       D            18015057    B Y F   STAFF ASSISTANT U OF M                 200.00  5 24 74   5 24 74      1.00  OT  * 040
                      STAFF      90084            4  ASST DIR OF FINAN AID SERV          10,400.00 1      1   7 01 75

     82913  S          D         02004538    E Y M   STAFF ASSISTANT U OF M                 296.12  8 30 70.  7 02 74      1.00  01    040
                      STAFF      90084            4  STAFF ASSISTANT                     15,398.24 4      3   7 02 77

     83407  S          L         02000408    E Y M   ASSOC DIR PLCMT FIN AID U OF M         371.47 11 01 64   4 28 74      1.00  01    051
                      STAFF      90257            5  ASSOC. DIRECTOR OF FINANCIAL A 19,316.44 5      5   4 28 79

     83841  S          G         02002272    E Y M   ASST DN OF STUDENTS U OF M             393.91 12 19 65   2 02 75      1.00  01    050
                      STAFF      90265            5  COORD OF STUD EMPLOYMENT            20,483.32 5      1   2 02 76

     86711  W       M            18050002    E Y F   SENIOR CLERK AND TYPIST                145.05  7 21 68   6 29 69      1.00  OT    060
                      CLASSIFIED 06530         5  2  SECRETARY                            7,542.60

     93816  W     B          ,   18050006   .E Y F   SENIOR CLERK AND TYPIST                149.30  4 17 66  .4 17 66      1.00  OT    060
                      CLASSIFIED 06530         6  2  SECRETARY                            7,763.60

                                 M    F                 A    B    C    D    E    F    G    H
** PROFESSIONAL **      * SEX *  005  001    * RACE *  000  002  000  000  004  000  000  000
                                 M    F                 A    B    C    D    E    F    G    H
**  CLASSIFIED  **      * SEX *  000  005    * RACE *  000  000  000  000  005  000  000  000
```

FIGURE 3

AFFIRMATIVE ACTION REPORTING SYSTEM

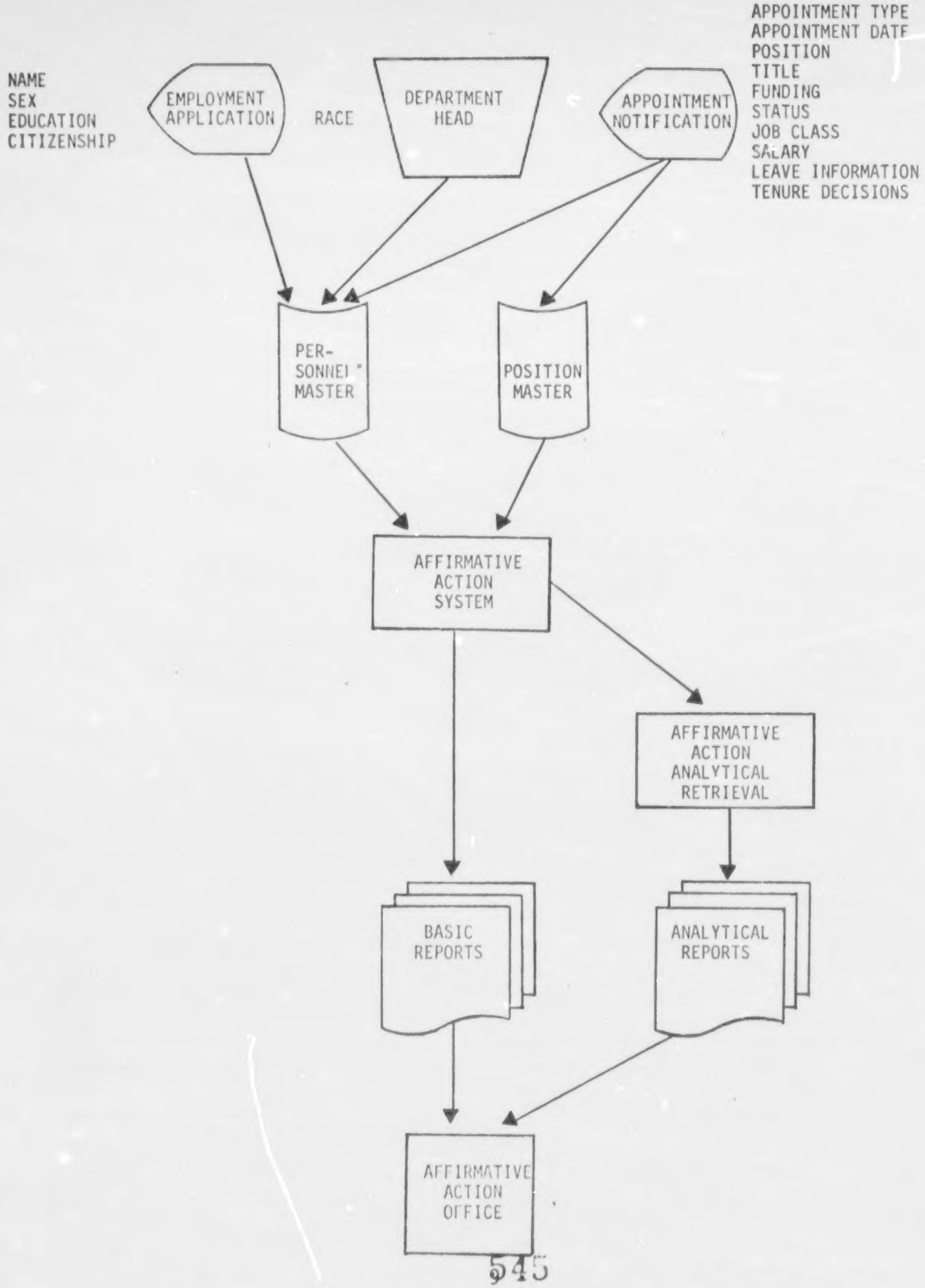
NAME
SEX
EDUCATION
CITIZENSHIP
EMPLOYMENT APPLICATION
RACE
DEPARTMENT HEAD
APPOINTMENT NOTIFICATION
APPOINTMENT TYPE
APPOINTMENT DATE
POSITION
TITLE
FUNDING
STATUS
JOB CLASS
SALARY
LEAVE INFORMATION
TENURE DECISIONS
PER-SONNEL MASTER
POSITION MASTER
AFFIRMATIVE ACTION SYSTEM
AFFIRMATIVE ACTION ANALYTICAL RETRIEVAL
BASIC REPORTS
ANALYTICAL REPORTS
AFFIRMATIVE ACTION OFFICE

FIGURE 4

AFFIRMATIVE ACTION REPORTING SYSTEM
RUN REQUEST

1. PROGRAM REQUESTED:
   - PER32800 ☐ (All Staff)
   - PER32800F ☐ (Faculty Only)
   - PER32800H ☐ (New Hires)
   - PER32800T ☐ (Terminations)

2. CONTROL CARD FORMAT:

CAMPUS: ☐ (cc 1)

AMHERST = A
BOSTON = B
WORCESTER = W
PRESIDENT = P
COMMON SERV. = C
ALL CAMPUSES = ƀ

AREA: ☐☐☐ (cc 3- 5)

STUDENT AFFAIRS = STD
ACADENT AFFAIRS = ACA
ADMINISTRATIVE SERV. = ADM
CHANCELLOR'S OFFICE = CHC
ALL AREAS = ALL

REPORT TYPE: ☐☐☐☐☐ (cc 7-11)

INDIVIDUAL LISTS = LISTS
RACE/SEX TABLES = TABLE
LISTS AND TABLES = ƀ

DART OPTION: ☐☐☐☐ (cc 13-16)

DART TAPE WANTED = TAPE
NO DART TAPE = ƀ

PERCENT: (PER32800 AND PER32800F ONLY) ☐ (cc 18)

FULL TIME ONLY = 1
PART TIME ONLY = 0
ALL = ƀ

START/STOP DATES: (PER32800H AND PER32800T ONLY)

FORMAT IS YYMMDD

START: ☐☐☐☐☐☐ (cc 18-23)
STOP : ☐☐☐☐☐☐ (cc 25-30)

Cost and Benefits

Since the purchase of new hardware or software was not required in putting up the system, the only cost involved programmer time and materials. It has earlier been noted that 60-75 person days (FTE) were required to design and implement the system. Translated into development/redesign cost of $65/day, this amounts to a total cost of $4,000 - $5,000. This investment compares very favorably with the commercial packages available for affirmative action data retrieval. These packages consist of basically two types:

1. Separate affirmative action data retrieval packages priced from $7,000 to $10,000
2. Complete personnel system packages priced from $20,000 to $40,000

Commenting further on these commercial packages, it is important to note that these data retrieval analysis systems appear to be less comprehensive than the system at the University of Massachusetts. Besides the cost benefits of the system (development and maintenance cost) there are other benefits such as the multiplicity of applications, timely updating, and ease of program expansion. The following is a list of some of the system's applications:

1. Completion of federal affirmative action reporting requirements
2. Completion of state affirmative action reporting requirements
3. Assessment of salary equity requests
4. Information for internal affirmative action planning
5. Verification of staff as of a particular date
6. Calculation of personnel salary savings
7. Comparison of various staffing variables by campus
8. Analysis of termination characteristics

9. Assessment of staff promotion patterns
10. Tracking of tenure decisions

As an integrated data system, a single update of common data provides all applications with new information simultaneously. Therefore, the total integrated system is able to process new data immediately after update. The other noted system benefit relates to the use of the DART option. The DART package not only facilitates system expansion but also provides users the opportunity to design their own sub-programs. This benefit, perhaps more than any other, captures the essence of the data system--simplicity.

> *"In character, in manners, in style, in all things,*
> *the supreme Excellence is simplicity."*
>
> *Henry Wadsworth Longfellow*

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TRENDS IN EDUCATION DATA BASES: PRESENT AND FUTURE APPLICATIONS AND CAPABILITIES

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This paper discusses the present national databases situation in higher education; that is, availability of data, methods of retrieval, and uses made of the retrieved data. This paper also discusses trends which will greatly enhance the uses of databases, including: a computerized cataloging system for classification of data elements; a modular retrieval system (EDSTAT is currently working on this); increasing reliance on microfiche; and computer graphics. Some of these techniques have already been developed; others are still being developed.

TRENDS IN EDUCATION DATA BASES
PRESENT AND FUTURE APPLICATIONS AND CAPABILITIES

I. INTRODUCTION

This paper discusses the present situation of national data bases in higher education and gives suggestions for future developments and enhancements. The paper limits itself to data bases collecting information on a national level because more and more administrators and decision makers are realizing that they need national data to formulate a viable policy or make a good decision. In discussing data dissemination, the paper refers to the dissemination of data which are in the public domain. It is hoped that some of the suggestions will not only serve as food for thought, but will in fact be implemented in the near future.

II. THE PRESENT DATA BASE APPLICATIONS

As most offices of institutional research at major universities or colleges will agree, there is a wealth of data about the universities and colleges for policy decision makers to use. As most decision or policy makers in higher education will agree, there just aren't enough usable data available for policy decisions. The data are being collected, but they are not being put into a form which the policy makers can easily use. Colleges and universities fill out myriads of forms and put out thousands of reports a year. Who does anything with all this information once the report is published or the form is completed? Obviously, there are usually in-house, one-time uses for most of this information; but many times the report is made with almost no one noticing it, let alone using the information in the report. The problem is that there is not a central place or organization to take care of data in higher education, so there is no one source to which to go to find data in higher education.

There does exist a vast quantity of individual data sources in higher education. Almost every institution has some type of information system. But bringing all this information together is a tremendous task, and probably not worth the time and effort for most people. There are several national sources for data in higher education which have tried to select forms of data which a policy maker or researcher might be able to use. These organizations have put together data bases, seeing that the only efficient method to deal with the quantity of information is in an automated fashion.

What Data Is Available?

There are essentially three central sources for locating data in the field of higher education. The broadest of these sources is the Reference Guide to Postsecondary Education Data Sources.[1] This is published by the National Center for Higher Education Management Systems.

A second source is the Catalogue of Selected Machine-Readable Data Bases for Postsecondary Education[2] published by the National Education Data Library. This is an inventory of data from both public and private sources which is in machine-readable form. It limits itself to data in higher education.

The third source is the Directory of Federal Agency Education Data Tapes[3] put together by the National Center for Education Statistics. This contains a listing of data from the federal government which has been put on magnetic tape. It does not limit itself to data about higher education, but also includes data from elementary and secondary education. It looks at education in the broad sense of the word and includes information about manpower supply and demand, demography, libraries, and federal outlays for education.

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[1] Katherine H. Allman, A Reference Guide to Postsecondary Education Data Sources (Boulder, Colorado: NCHEMS at WICHE, 1975).

[2] John R. Roberts, Catalogue of Selected Machine-Readable Data Bases for Postsecondary Education (Washington, D.C.: National Education Data Library, 1975).

[3] Barbara A. Feller, Directory of Federal Agency Education Data Tapes (Washington, D.C.: National Center for Education Statistics, 1976).

All three of the above sources furnish the reader with information about where the data can be obtained and in what form. They also give the name of a person who should be contacted to obtain the desired data.

Present Data Bases

There presently exist three national data bases dedicated to higher education which can be accessed by the general public. These systems are the Education Resources Information Center (ERIC) of the National Institute of Education, EDSTAT II of the National Center for Education Statistics, and the data base of the National Education Data Library (NEDL).

ERIC is a bibliographical retrieval system and was designed to provide ready access to education literature. Abstracts from Research in Education and from Current Index to Journals in Education form the basis for the data. Each abstract is indexed with a series of descriptors from the Thesaurus of ERIC Descriptors. Searches are then undertaken by combining a series of descriptors through Boolean logic to the subject category or categories at which the user wishes to look. The user obtains a list of abstracts through a search, and from this list he decides at which articles he or she wishes to look. There are 16 clearinghouses in the ERIC system, each having a specialty area about which it is responsible for acquiring educational data. ERIC will provide the user with a list of abstracts and also the articles on micro fiche if the user wishes. The

ERIC system can be accessed by an ERIC staff person, and the length of time to service a request is usually about a week because the desired information is printed on a high speed printer at the computer site, then mailed to the office where the request originated, and then, in turn, mailed to the person originally requesting the information.

This is not a very efficient way of accessing the ERIC data base. A time lag of one week is just too long. A research assistant could go to a library and find the appropriate articles in one or two days. For this reason, the general public is given access to the ERIC data base through the Lockheed DIALOG Information Retrieval Service which is a division of Lockheed Aircraft Corporation based in Burbank, California. Access is, of course, interactive and on-line. Once the desired abstracts are located, the user still has to request from ERIC that the actual articles be sent to him or her either in hard copy form or micro fiche.

The ERIC system is a very comprehensive system in terms of educational research, and many articles which might be difficult to find can be obtained in micro fiche through the ERIC system. ERIC is the best bibliographic retrieval system which higher education has.

EDSTAT II is a data base containing actual information about higher education institutions as opposed to a bibliographic data base. Raw data from the Higher Education General Information Surveys (HEGIS) make up the bulk of the EDSTAT II data base; however, the data base also contains data from some of the other federal governmental agencies. EDSTAT II can be accessed by the general public using a terminal with an accoustical hook-up. The system is operated through INFONET. EDSTAT II uses a retrieval language called "System 2000". System 2000 is fairly flexible and can be used for a variety of statistical analyses. The disadvantage is that only a limited number of people are familiar with the language, and it takes someone with a basic understanding of computers to learn the language.

EDSTAT II is the largest data base, organized by institutions, which provides access to the general public. The information which one can access includes almost all of the HEGIS data over the past three or four years. So one can conceivably put together trend data for the past few years, and from this data put together forecasting models. At the present time EDSTAT II is trying to put together a broader scope of data by putting on-line other federal data bases which relate to education. Also, EDSTAT II at the present is relatively expensive compared to the data base of the National Education Data Library. The National Center for Education Statistics is working on keeping the cost of EDSTAT II low so that a greater number of users can access the system.

The National Education Data Library's data base is similar to EDSTAT II in that it contains data about institutions in higher education. The Data Library has data from private as well as public sources. The retrieval language which the Data Library uses is called the Data Library Access Language (DLA). It is a user-oriented interactive language designed so that someone with little computer background can learn the language in a very short period of time. DLA is designed as a retrieval language so that the statistical analysis that one can do using DLA is limited to fairly simple descriptive statistics such as standard deviations and means.

The National Education Data Library's data base can be accessed by the general public using a terminal with an accoustical coupler. Since the Data Library does not keep as many files on-line as EDSTAT II (although both data bases have the ability to put up new files in a very short time), the cost of retrieval is significantly less. The Data Library is also attempting to expand its library of tapes to include not only education data by institution, but any data which might influence education decisions. This would include state and local government expenditures or manpower supply and demand data, for example.

How Is the Data Used?

This is a question which should be given more consideration than it is presently getting. Information systems containing data about higher education on a national level are a relatively new thing. The information has been available, but no one could afford the time or amount of effort to get the information. So decisions were made without using the most precise data which were available. As a member of a New York state legislature's staff on a recent Information in Higher Education Seminar put on by the National Education Data Library said, "There are two things that you don't want to see being made: hotdogs and laws." This also applies to laws about higher education and decisions made at the state level in higher education.

Until fairly recently, decision makers didn't have access to good data and therefore had to make decisions the best they could with what they had available to them. This is no longer the case, however. Among ERIC, EDSTAT II, and the National Education Data Library, information about higher education is being collected and put in a form where it can be easily retrieved and analyzed at a minimal cost. No longer does one have to wait several weeks for a report comparing enrollment at state schools in California to enrollment at state schools in New York.

This can be done in a couple of minutes on either of the EDSTAT II or NEDL systems with minimal effort and low cost. If one wanted to find recent articles or research about enrollment in these two states, ERIC would be a convenient way of doing this. It is beyond the scope of this paper to discuss the best method of making a decision, but it seems apparent that the more reliable data that a decision is based upon, the better that decision will be.

The state of the art for higher education at this time is such that the only major automated systems for retrieving information which can be accessed by the general public are the ERIC, EDSTAT II, and NEDL systems. Each of these systems is primarily a retrieval system with the EDSTAT II and NEDL systems having the capability of doing simple analysis. The next section of this paper deals with application of data bases in other disciplines as an example of possibilities for future uses of data in higher education.

Data Bases in Other Disciplines

There are numerous commercial data bases, in other disciplines besides higher education, currently in use. This paper will present a few to give examples of possible directions which higher education data bases might take.

1) LEXIS is a data base provided by Mead Data Central, Inc. It is used for research in law. It currently contains laws and cases for approximately ten states. For example, the "library" for the state of New York contains:

    Consolidated Laws of New York
    New York Reports and New York Reports 2nd Series
    New York Appellate Division Reports 2nd Series
    New York Miscellaneous Reports 2nd Series

    LEXIS is available through remote terminals to anyone who wants to use it. Essentially it is a retrieval system for laws and court cases. The retrieval language is very simple and not dependent upon specific index words. For instance, if the user requested a search for the word "pollution", every case in the specific library within which the search was requested which contains the word "pollution" would be cited. This means that there is no abstracting of the laws or cases and that a systems person does not have to categorize all the laws and cases into some indexing system. Once the number of cases or laws has been narrowed down, the user can search through the pertinent laws and cases using KWIC (key work in context). This permits the user to view only those textual portions which contain one or more of the search words or phrases used in the request.

The nice feature of this system is that there is no need for a thesaurus of index words for retrieval of information. It does save a tremendous amount of time for the law firms which do use the system.

2) CRIS (Current Research Information System) is a data base put together by the United States Department of Agriculture. It was designed to help people keep abreast of research in agriculture. It is similar to the ERIC system in that it contains abstracts from research reports, but it is more current in that it also keeps track of on-going research projects. Therefore, this data base is continually up-dated. The retrieval system is similar to ERIC's in that both use a key word retrieval method. The advantage of this system is that it contains abstracts from research projects which haven't been published yet.

3) SCORPIO (Subject-Content-Oriented Retriever for Processing Information On-Line) is a system developed for the United States Congress. This data base contains, among other data, all the laws which have been proposed in the present session of Congress and for the previous

session. The user can retrieve abstracts or summaries of specific laws or print the entire law. A user can search on a variety of subject key words or he can search on the name of the Senator or Congressman submitting the bill. SCORPIO is designed for the person who is not familiar with computers or computer systems.

4) The Information Bank of the New York Times is a data base containing abstracts from current periodicals. The retrieval method is similar to ERIC's retrieval method. Abstracts can be retrieved by searching with combinations of designated key words. The Information Bank can be accessed by the general public through remote terminals. The significance of this data base is its scope. See Table 1 for a listing of periodicals and newspapers included in this data base.

5) Data Resources, Incorporated is a private firm which has a data base of economic indicators available for use by the general public on a subscription basis. One can access several different data banks in the system. A listing of the scope of the data is provided in Table 2. This system is accessed by a remote terminal. The significance of this system is in its software packages. One can print reports and retrieve information, but also there is an interactive facility for displaying time series data in graphic form. The software also provides a variety of estimation and statistical procedures used in economic analysis. Although this system is one of the more expensive systems discussed in this paper, it is one of the most sophisticated. Training in the use of this system only takes three consulting days.

The above systems are currently in operation and operating successfully. Each system is different, and each has features which the present national

TABLE 1

PERIODICALS AND NEWSPAPERS INCLUDED IN THE NEW YORK TIMES INFORMATION BANK

General Circulation Newspapers:

Atlanta Constitution
Chicago Tribune
Christian Science Monitor
Houston Chronicle
Los Angeles Times
Miami Herald
National Observer
New York Times
San Francisco Chronicle
Washington Post

Business Publications:

Advertising Age
American Banker
Automotive News
Barron's
Business Week
Editor and Publisher
Forbes
Fortune
Harvard Business Review
Journal of Commerce
Wall Street Journal

Foreign Affairs:

Atlas
Economist of London
Far Eastern Economic Review
Foreign Affairs
Foreign Policy
Latin America
Latin America Economic Report
Manchester Guardian
Middle East
Times of London

Science Publications:

Astronautics
Bulletin of Atomic Scientists
Industrial Research
Science
Scientific American

Newsweeklies, Monthlies, Quarterlies:

American Scholar
Atlantic
Black Scholar
Commentary
Commonweal
Consumer Reports
Current Biography
Ebony
Harpers
Nation (The)
National Journal
National Review
New Republic
New York
New York Review of Books
New Yorker
Newsweek
Psychology Today
Saturday Review
Sports Illustrated
Time
US News and World Report
Variety
Village Voice
Washington Monthly

TABLE 2

DATA SOURCES OF DATA RESOURCES, INC. DATA BASE

1) FDIC Call Report Data
2) HUD Housing Survey - Public Housing Default Study
3) NABE Economic Outlook Survey
4) Multi-National Corporations Survey
5) Federal Budget
6) Justice Department Victimization Survey - 13 Cities
7) OECD Trade Series C
8) WPI Price Data Bank
9) IPI Price Data Bank

data base systems in higher education do not possess. In the near future some of these features could very easily be incorporated into data systems in higher education.

III. FUTURE CAPABILITIES

Future Directions

The five systems in the previous section each demonstrate one feature which might be fruitfully applied to a higher education information data bank. LEXIS has the feature of being able to search on virtually any word which the user can come up with. The user does not have to categorize the research area into a narrowly defined indexing system. Any reference to specific words or phrases can be retrieved. This feature might be useful in a system like ERIC when the researcher wants to find any research which has any connection whatsoever with his subject area.

CRIS is constantly being updated and contains abstracts of research projects which have not been published yet. This type of system might be very useful for a decision maker who wanted the very latest information about a specific subject area. Through this type of system the decision maker would be able to get in contact with people who are just finishing or in the process of doing research in the area in which the decision maker is interested.

SCORPIO carries CRIS one step further in timeliness. In SCORPIO the user surveys bills that have been proposed - sometime they pass, sometimes they die. One possible use in higher education for this type of system would be for government grant proposals. It might be of value for a person writing a grant for the Office of Education or other government or private agency to review past proposals which were given money or rejected.

The Information Bank of the New York Times is important because of the scope of the data in that data base. It draws upon science publications, business publications, newspapers, and general periodicals. Too often in higher education researchers and decision makers get stuck in the ivy tower and don't know how to get out. At the present time the most widely used data in higher education research and policy decisions are the Higher Information General Information Survey data. However, if one makes a decision or researches a problem in a matter as simple as raising tuition at state institutions within a particular state, there are a wide variety of parameters which influence the effect of such a change. At the present time the enrollment projections would be the most likely figures to look at for a change of tuition decision. However, there is a variety of reasons why enrollment would fall or drop. One has to look at job supply and demand, family income of students attending the school, and the reasons which the students attend school, to name just a few things affecting the decision. Most of this data is available, but it is much too time consuming and expensive to put together. For this reason it would be benefitial for systems like EDSTAT II and NEDL to expand the type of data which they are making available to users. As any managerial school will attest to, in making a decision, the good manager looks at the whole picture and the effects of his decision on the future, rather than just looking at the immediate effect. To do this a variety of different types of data is needed.

Data Resources, Inc. provides a variety of tools to do interactive statistical analysis. There is no technical reason that the higher education data bases which currently exist can't make software such as Statistical Package for the Social Sciences (SPSS) available to the users of the system. The only drawback of this at the present time is the cost of making this software available. I am confident that in the near future a software system similar to Data Resources, Inc. will be made available to the higher education community on national data bases.

Data Elements Catalogue

One of the major problems of a decision maker or researcher is knowing what data is available for his or her use. Once the probable source is located, one is still uncertain if the exact data need will be in the source. For example, if one wants to know the number of women enrolled as graduate majors in education in the state of New York, where can this information be found? After looking through the various sources listed in the subsection entitled "What data are available?", one would probably come up with two possibilities as sources for this data. The HEGIS enrollment data and the HEGIS enrollment for advanced degress data would be probable sources for obtaining this data. As it turns out,this specific question can be answered in the HEGIS enrollment for advanced degrees data. The only way to ascertain this at the present time is to sit down and look through the actual survey forms or the data base directories put out by both EDSTAT II and NEDL (see Figure 1). As one can see, this becomes a long, drawn-out process.

The question then becomes - why not organize the data elements into some sort of classification system? After all, libraries containing books have had classification systems for years. Data elements are like books. If one has a large quantity of them without some sort of classification system, some will necessarily be missed in any retrieval process.

It seems that with a subject area as small as education, it would be fairly easy to come up with some sort of classification system. On a data base system this classification could be part of the data base. If

```
|  COMPONENT   |                    COMPONENT DESCRIPTION                    |    OUTPUT       | FORMAT
|    NAME      |                                                             |    HEADING      |
|==============|=============================================================|=================|=======
| C# 89        | FACULTY ON A 11-12 MONTH SALARY CONTRACT                    |   11MO-WOMEN    |  616  |
|              | ASSISTANT PROFS WOMEN TENURED                               |    TENURED      |  8, 0 |
|              |                                                             |                 | N CT  |
|--------------|-------------------------------------------------------------|-----------------|-------|
| EMP5IN11MN   | FULL TIME INSTRUCTIONAL FACULTY-FY 1975                     |  INSTRUCT-75    |  617- |
| C# 90        | FACULTY ON A 11-12 MONTH SALARY CONTRACT                    |   11MO-MEN      |  624  |
|              | INSTRUCTORS MEN NUMBER                                      |    NUMBER       |  8, 0 |
|              |                                                             |                 | N CT  |
|--------------|-------------------------------------------------------------|-----------------|-------|
| EMP5IN11MMS  | FULL TIME INSTRUCTIONAL FACULTY-FY 1975                     |  INSTRUCT-75    |  625- |
| C# 91        | FACULTY ON A 11-12 MONTH SALARY CONTRACT                    |   11MO-MEN      |  632  |
|              | INSTRUCTORS MEN MEAN SALARY                                 |  MEAN SALARY    |  8, 0 |
|              |                                                             |                 | N$CT  |
|--------------|-------------------------------------------------------------|-----------------|-------|
| EMP5IN11MT   | FULL TIME INSTRUCTIONAL FACULTY-FY 1975                     |  INSTRUCT-75    |  633- |
| C# 92        | FACULTY ON A 11-12 MONTH SALARY CONTRACT                    |   11MO-MEN      |  640  |
|              | INSTRUCTORS MEN TENURED                                     |    TENURED      |  8, 0 |
|              |                                                             |                 | N CT  |
|--------------|-------------------------------------------------------------|-----------------|-------|
| EMP5IN11WN   | FULL TIME INSTRUCTIONAL FACULTY-FY 1975                     |  INSTRUCT-75    |  641- |
| C# 93        | FACULTY ON A 11-12 MONTH SALARY CONTRACT                    |   11MO-WOMEN    |  648  |
|              | INSTRUCTORS WOMEN NUMBER                                    |    NUMBER       |  8, 0 |
|              |                                                             |                 | N CT  |
|--------------|-------------------------------------------------------------|-----------------|-------|
| EMP5IN11WMS  | FULL TIME INSTRUCTIONAL FACULTY-FY 1975                     |  INSTRUCT-75    |  649- |
| C# 94        | FACULTY ON A 11-12 MONTH SALARY CONTRACT                    |   11MO-WOMEN    |  656  |
|              | INSTRUCTORS WOMEN MEAN SALARY                               |  MEAN SALARY    |  8, 0 |
|              |                                                             |                 | N$CT  |
|--------------|-------------------------------------------------------------|-----------------|-------|
| EMP5IN11WT   | FULL TIME INSTRUCTIONAL FACULTY-FY 1975                     |  INSTRUCT-75    |  657- |
| C# 95        | FACULTY ON A 11-12 MONTH SALARY CONTRACT                    |   11MO-WOMEN    |  664  |
|              | INSTRUCTORS WOMEN TENURED                                   |    TENURED      |  8, 0 |
|              |                                                             |                 | N CT  |
|--------------|-------------------------------------------------------------|-----------------|-------|
| EMP5LT11MN   | FULL TIME INSTRUCTIONAL FACULTY-FY 1975                     |  LECTURERS-75   |  665- |
| C# 96        | FACULTY ON A 11-12 MONTH SALARY CONTRACT                    |   11MO-MEN      |  672  |
|              | LECTURERS MEN NUMBER                                        |    NUMBER       |  8, 0 |
|              |                                                             |                 | N CT  |
|--------------|-------------------------------------------------------------|-----------------|-------|
| EMP5LT11MMS  | FULL TIME INSTRUCTIONAL FACULTY-FY 1975                     |  LECTURERS-75   |  673- |
+-------------------------------------------------------------------------------------------------+
FILE-DATE 01/22/76                             EMPSAL75
```

FIGURE 1

DATA BASE DIRECTORY

the classification system worked on Boolean logic, the example above might be found by searching for:

ENROLLMENT AND WOMEN AND GRADUATE AND EDUCATION MAJOR.

The classification system would then indicate the file or files where this information would be found. This type of system would save a tremendous amount of time in searching for the proper information or data source. One would know immediately if the data which he or she requested were on the data base and also if there were several sources for the same information.

Combining Files

A problem with interactive data bases is that search time always has to be kept down to a minimum. To keep search time down to a minimum both interactive data bases in higher education (EDSTAT II and NEDL) divide their data into files. This not only keeps search time down but makes putting additional data on-line and taking unused data off-line an easy task. Also, with a large volume of data it is easier to keep track of the several small files than one huge file containing data from a variety of sources. The difficulty experienced by the user of such an interactive system is that when printing reports (due to present software constraints), the report is limited to a specific file. Different reports can come from different files, but data within a report are limited to one file.

This is inconvenient when one wants to do trend analysis, since most files contain only one year of data. There should be some procedure written into the software whereby files could be merged on-line by a simple command. Then the user would be able to access more than one file at a time. It is important to keep the software simple so that someone with minimal computer background can use the system. Both EDSTAT II and NEDL are looking at methods to combine files on-line.

Computer Graphics

To the layman a computer can be a scary experience; lists of numbers don't mean much; and the laymen doesn't even want to hear the word statistics. However, a picture is worth a thousand words. In communicating an idea, a picture is much easier to understnad than a series of numbers. This is especially true when trying to communicate to a group of people. At most presentations of technical or non-technical material, the speaker will use visual aids in the form of graphs or charts.

Most graphs or charts are made by the research assistant or the secretary by sitting down and painstakingly drawing lines to match the numbers. It would save much time and aggravation if the charts and graphs could be printed directly on the computer terminal. It would be a tremendous convenience if, instead of getting a report with a list of numbers from the remote terminal, one received a pie graph or a bar graph. Software is available for creating either of these graphs and also many others. The only thing that has to be done is adapting the software to the specific system.

IX. ASSUMPTIONS WHICH THE PAPER HAS MADE

There are three basic assumptions which this paper has made. The first assumption is that national data in higher education can and should be used in decision and policy making at the national, state, and institutional level. A prime concern of anyone using data should be the accuracy of that data. The most sophisticated analysis doesn't mean anything if the data it was based upon were incorrect. However, it is better to make a decision from data for which the level of confidence is known, than from suppositions because totally accurate data are not available. The national data on higher education are not 100% accurate by any means; however, it is only by use of the data that they become more accurate. Data are used constantly in making business and economic decisions. This is because the data have been well tested by widespread use.

The second assumption is that anyone who wants to use the information and data collected in higher education should be permitted to do so. This assumption necessarily means that information and data will be misinterpreted and misused. Especially in the field of education, one has to have faith enough to pass on information. That is what education is all about. To limit access to a select few would be like not teaching science in school to certain students because they may misuse it. It is the responsibility of the person or organization providing the information or data to furnish enough documentation so that the chance of misinterpretation will be minimal.

The third assumption is that if data should be available to everyone, then the exchange and use of data should assume a high priority in higher education. It seems futile to fill out the vast number of forms and reports which most institutions of higher education submit to one agency or another and then never to be able to use that information. Organizations like ERIC, NCES, and NEDL should make an organized effort to let people know what information is available about higher education.

V. CONCLUSIONS AND RECOMMENDATIONS

This paper has been designed to point out the present situation of national data bases in higher education and to suggest some future capabilities of data bases in higher education. The present situation in national higher education data bases is a relatively new field. Computerized methods of data dissemination until recently were too expensive to be practical for most groups. However, now data dissemination by computer data base is becoming an established practice. The future capabilities which were discussed were not bold and innovative. Most of the suggested capabilities already exist on information systems in fields other than higher education.

The future recommendations made in this paper were designed to make access to information easier for the user. The computer should be used as a tool and as a means to an end. The retrieval system should be simple enough so that a person with minimal training and computer background could use the system.

It is hoped that some of the ideas expressed in this paper will be initiated, but more importantly that the ideas will stimulate more thought for further improvement of data bases in higher education. The art of using data, as in most disciplines, is still in its infancy in higher education. People still don't know where to find or even look for data. As people gain access to more pertinent and more accurate data it is hoped that better and more equitable decisions can be made about higher education.

MANAGEMENT OF THE DATA RESOURCE: INFORMATION ABOUT INFORMATION FOR YOUR INFORMATION

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This paper addresses UAB's efforts in managing and controlling the University's data resource. Subtopics covered include: the UAB techniques and philosophy of data administration as a significant factor in the management of the data resource; the coordination of the data resource as it pertains to the data processing function, the data administration function, and the user community; and the specific techniques employed at UAB utilizing the IBM Data Dictionary System as a major management tool.

I. INTRODUCTION

Any concept of Data Administration is strongly influenced by the organizational environment in which it is implemented. There are probably as many data administration concepts as there are organizations which recognize this function. A good yard stick by which to judge data administration philosophies is: If it is effective in the environment in which it must function, then it's good.

For example, in an organizational environment where the lines of management are well defined, Data Administration which projects the image of "DATA CZAR" may be efficient and effective. However, this same approach may be totally unworkable in an environment where the lines of management are not well defined. Thus, data administration philosophies are generally not transportable across institutions.

This paper addresses UAB's concept of Data Administration and our experience in its implementation. Both are influenced by UAB's needs, organizational environment and personalities involved. The reasons for the cognition developed are married to the environment. To understand the philosophy divorced from the environment has no meaning.

II. THE UAB DATA ADMINISTRATIVE ENVIRONMENT

The structural organization of UAB can be described as a loose coalition of institutions. Departments are organized into divisions or schools. Each of these in turn have a representative at the Vice-Presidential level who report directly to the President.

The UAB data administration function is organized within the Department of Central Computing Facilities. The Department of Central Computing Facilities is organized within the Division of Biophysical Sciences. The Director of Biophysical Sciences has dual responsibilities. He reports to the Vice-President for Health Affairs, and also to the University President as Assistant to the President for Computing Affairs.

The role of CCF in this organizational environment is:

1. To meet the administrative data processing needs of the University by designing, developing, and supporting applications in that area.
2. To meet the generalized research computing needs of the University by providing specialized education, consultation, and hardware/software facilities.
3. To meet the academic data processing needs of the University by providing consultation and the hardware/software facilities to support student computing.

The UAB data administration environment has functional relationships that extend beyond the structural relationships. These functional relationships provide a communication media between organizational management and the administrative data processing user community.

1. The Data Administrator functions as a communication interface between the individuals in the Administrative Data Processing user environment. The administrative data processing needs of the institution are represented by the collective needs of the institution in the user environment. The needs of the specific individuals in the user environment may sometimes be in conflict with

the collective needs of the user environment. The Data Administrator acts in the capacity of advisor and consultant to the Administrative Users in resolving differences, thereby, unifying the collective needs.

2. The Data Administrator functions as a communication interface between the Administrative user environment and institutional management. The Data Administrator performs this function by the origination of policies and procedures which represent the collective needs of the user community. These policies and procedures are then passed up to institutional management for approval. In this capacity the Data Administrator is giving advice and assistance to institutional management.
3. The Data Administrator communicates the needs of institutional management to the administrative user community by enforcing policies and procedures within the user environment.

A specific example of how this process has worked at UAB follows. The first major involvement of the UAB Data Administrative function was in the design of an IMS based Payroll/Personnel System. This system was designed to meet a wide variety of user department needs (Payroll, Personnel, Faculty, etc.). Representatives from each user group participated extensively in the system definition, including the definition of each data element necessary to meet the system requirements. From this discussion it became apparent that guidelines pertaining to element access were needed. The Data Administrator recommended a security code policy to institutional management. DA COMMUNICATES USER NEEDS TO INSTITUTIONAL MANAGEMENT. Approval of this policy by institutional management enabled the Data Administrator to establish and enforce data security standards applicable to all data elements and all administrative users. INSTITUTIONAL MANAGEMENT COMMUNICATES NEEDS TO USER ENVIRONMENT.

This policy served as a basis for discussions and the resolution of user differences regarding the security and access of system data elements. It is interesting to note that these differences were resolved by the user themselves with the Data Administrator acting in an advisory role. DA COMMUNICATES WITH USERS TO RESOLVE CONFLICT.

III. MANAGEMENT OF THE DATA RESOURCE

The justification most often advanced for installation of a Data Base Management System is to improve the acquisition, storage, quality and availability of data; as well as to provide additional security and maintainability of the data base. The most important facet of the current movement toward data base systems is centralized control and supervision of the data resource through the Data Administrative function. Implementation of this function involves data definition methods, data standarization, and changes in the use and processing of data. The primary responsibility of the Data Administrator is the management of this centralized data resource.

A. THE UAB DATA RESOURCE

At UAB the data resource consists of those data which meet the administrative data processing needs of the institution. The criteria for inclusion of data into the UAB Data Resource include:

1. The data must be in machine processable form.
2. The data in machine processable form must be physically resident in data base structure.
3. The data must be documented and available to the user community in standard maintainable format.

Two basic approaches to the development of the data resources have been taken by most institutions. Some institutions attempt to document all existing data in machine processable form thereby incorporating that data into data resource. Other institutions have elected to start at some point and document all new or selected new data thereby incorporating it into the data resource.

At UAB we have elected the latter approach for the following reasons:

1. If we attempted to document all existing machine processable data then most of it would probably be obsolete by the time we finished--if we ever finished.
2. Starting with the design of new IMS based applications would permit us to develop procedures and standards on a workable subset of the total data resource. In a few years the majority of the machine processable data would be defined in the data resource since
   a. All new major applications will be designed as IMS based applications when such is appropriate.
   b. Needs for older application tend to go away after a period of time or be so extensively modified

that consideration will be given to rewriting as IMS based applications.

B. MANAGEMENT CHARACTERISTICS OF THE DATA RESOURCE

Management of the data resource separates itself into two functional areas: Management of the Organizational Data Resources and Management of the Physical Data Resources.

MANAGEMENT OF THE ORGANIZATIONAL DATA RESOURCE

Management of the Organizational Data Resource is the responsibility of the Data Administrator. His function in this area is analogous to the University Controller in that he serves as custodian of the data resource. Responsibilities in this area include:

1. The selection and provision of the necessary tools to manage the data resource.
2. The definition of data attributes and procedures for their documentation.
3. The interpretation and enforcement of policies on data accessability.

MANAGEMENT OF THE PHYSICAL DATA RESOURCE

Management of the Physical Data Resource is the responsibility of the Data Base Administrator. This person reports directly to the Data Adminstrator. Responsibilities of the Data Base Administrator include:

1. Implement and maintain the data resource management tools selected by the Data Administrator.
2. Provide technical consultation and education to the Administrative programming staff in the areas of program implementation, program performance, and program debugging.

3. Incorporate policies and procedures interpreted by the Data Administrator into the design of the physical data resource.
4. Provide technical consultation and assistance to the Data Administrator.

These two areas of data resource management are different in precept but correlative in function. For example, in our experience with the Payroll/Personnel System, policy dictated that one department access only a subset of the employee records. The Data Administrator requested that the Data Base Administrator investigate and recommend a technical solution to implement this restrictive access. The solution, a sparse secondary index, reflected the requirements of the organizational data resource in the processing capabilities of the physical data resources.

C. FUNCTIONAL RESPONSIBILITIES OF THE DATA ADMINISTRATOR

How the Data Administrator at UAB performs his functional responsibilities in the management of the data resource will be considered in some detail.

C.1 SELECTION OF MANAGEMENT TOOLS

The basic tool selected for management of the organizational data resource is the IBM Data Dictionary Directory System. The function of this tool can be stated quite simply. The Data Dictionary contains "information about information for your information" in machine processable form. The decision to acquire such a tool was made concurrently with the deicsion to formally recognize the Data Administrative function.

The necessity to acquire such a tool as an aid in the management of the data resource cannot be exaggerated. The effective management of data requires a specific knowledge of data attributes, source, values, editing criteria and availability. This "information about information" is fully documented and maintained in machine processable form in the Data Dictionary Directory.

From this machine processable documentation, reports are produced and made available to the Data Administrator and user community. These reports are considered public documents. Every member of the institution has a right to this documentation in order to investigate the existence, validity, timeliness, security, maintainability, and definition of the datum in the data resource.

Knowledge of availability does not necessarily imply authorization to accessability. An analogy is: Every shareholder in any company has a right to know what funds, profits, expenses, etc., are associated with that company. However, knowledge of the funds does not imply the right to access those funds.

C.2 DEFINING THE DATA ATTRIBUTES

Data attributes selected for documentation include data quality, data availability and data maintainability.

MANAGEMENT OF DATA QUALITY

In managing the data resoure the Data Administrator is concerned with the quality of the data. Data quality includes: data validity, data timeliness, data definition, and data standarization.

DATA VALIDITY

The Data Administrator examines the need for the existance of each data item in order to reduce or eliminate extraneous or irrelevant data from the data base. In cooperation with the user, the Data Administrator secures agreements which define the tests of acceptability for each element.

For example, in our recent design of the Payroll/Personnel System, each element involved in that system was discussed with the user representative and documented. The discussion of each element always included references as to what tests of acceptability should be applied to that element before that value could be entered into the data base. In technical terms--what's the editing criteria. This discussion had three benefits:

1. It made the users more aware of element relationships since valid element values are often related to other elements. This awareness enabled the users to identify more specifically the system requirements.
2. Element editing now had a recorded standard. The programmer must use this criteria in editing the element before inclusion in the data base. Editing standards are no longer left to the imagination of the programmer.
3. Enforced standard editing results in increased productivity. The necessity for programmers to duplicate editing code from program to program was eliminated. There evolved many patterns of similar editing; element value must be a valid code; data entered must be valid date, etc. Subroutines were written to accomplish like editing functions. The name of the subroutines and any parameters necessary to call it were included as part

of the element documents. Hence increased programmer productivity and happier programmers.

Data Timeliness

The timeliness of data is an equally important aspect of Data Administration for assuring the quality of data. The financial world places considerable emphasis upon the time value of money. Rules and formulas are available for calculating the time value of money. Lack of a universally applicable standard for similar calculations does not diminish the time value of data; it just makes it difficult to determine that value. Data Administration must recognize that data does have a time value and select sources of input to the data base to maximize that value. The major role of the Data Administrator with regard to the timeliness of data is to develop and coordinate with considerable input from users, appropriate time standards for data; to determine and establish sources of data which meet these standards; and to establish and initiate both internal and external controls to insure compliance.

Documentation of the standards of data timeliness are recorded in the data dictionary. This includes the form name, number or description from which each element originates, the department(s) responsible for updating the element and the mode available for update (batch or online).

Those elements which have the capability of being updated in an online mode are considered to always reflect the latest most current value of the respective element. User department management is responsible for the timeliness of data elements updated on-line.

The timeliness of data updated in batch mode is the joint responsibility of the originating department and the computer center. Schedules are established with the originating department for submission of data. The data processing department is responsible for establishing and maintaining the actual updating run. Quality control of the batch updating process is assured by the reporting of actual updates against scheduled updates. This in-house designed application is an extension of the IBM Data Dictionary Directory System.

Data Definition

The process of data definition encompasses all the attributes so far discussed. These include: designation of functional responsibilities for data input, source documentation from which data input originates, frequency of input by responsible functional area, and editing criteria for each data element. The Data Administrator exerts significant influence upon the form and content, as well as the policies and procedures of the data definition process.

The UAB approach has been to orient the Data Dictionary Directory report format and contents toward the non-data processing personality. Data element descriptions, for example, were discussed at some length with the users prior to inclusion in the Data Dictionary.

The Data Dictionary document became the bible for discussing the needs and plans for the Payroll/Personnel System. The user group accepted several new concepts relative to data definition. Only those elements actually documented in the Dictionary were to be a part of the system. Elements not in the Data Dictionary were not to be included in the system. All editing was to be implemented exactly as described in the Data Dictionary. Screen designs and report formats were to be formulated from the information contained in the Data Dictionary.

Data Standardization

Data independence means that a single element of data stored once in the computer can serve more than one application. This concept, to be effective, demands that data be "standardized". For example, the data element "gross pay" can be accessed by both the Payroll and Personnel applications. If they agree, and the data element is used by both offices, its meaning cannot be changed without the agreement of both departments. The effective communication of information within an organization, therefore, depends on mutual agreement and understanding of all commonly used elements. The coordination of definitions cannot be left to chance but must become the responsibility of a designated function within the organization. Data Administration is the logical function to assume this coordinating responsibility. In this role, it can help resolve any conflicts which may arise by encouraging a continuation of dialogue, by offering compromise or, perhaps, adjudicating disputes. The UAB approach to the management of the data resource in the design of the Payroll/Personnel System resulted in a standardization of the data elements in that system as well as an application design which meets the stated needs of the users.

DATA AVAILABILITY

To be useful, data must be available to authorized users. Data Administration must balance this requirement against the need for data security. Maximum availability of data to all users implies little or no data security.

Maximum data security implies limited or no data accessability. Therefore, since the physical presence of data in a data base does not necessarily constitute accessability for a given user, a major function of Data Administrator is to monitor the accessability by enforcing procedures in regard to security policy.

In balancing data availability against data accessability, differences in interpretation of the security policy by the user and the Data Administrator evolve. If these differences cannot be resolved at the Data Administration level then the user(s) have a path of appeal to higher authority. The provision for this path of appeal is important in maintaining the user's perception of individual rights to data access. Without this path of appeal, the users may feel that their individual needs are not properly met.

The advantages gained from centralized data availability are offset somewhat by the necessity for more stringent security measures to protect the data base against accidental or intentional destruction, or disclosure of data to unauthorized persons. Security policies and procedures must consider legal requirements as well as the technical capability of current hardware and software to provide data security. It is often necessary to sacrifice program efficiency and optimum data base structure and processing efficiency in order to provide for maintainable security requirements.

In designing security measures, it is important to establish, throughout the organization, recognized responsibilities for the security of the data base. In our Payroll/Personnel discussions, the users collectively agreed to the security code associated with each element; the user group responsible for updating the element; and the user groups authorized to access that element. All of these items were included as part of the documentation. Furthermore, the following areas of security organizational responsibility were identified.

1. User Responsibility
    a. Assume responsibility for safeguarding issued passwords.
    b. Physical security for computer terminals.
    c. Security of sign-on procedures.
    d. Protection of printed reports containing sensitive data.
    e. Presence of an authorized person at the terminal.
2. Data Processing Department Responsibility.
    a. Proper and agreed upon data displayed at terminals.
    b. Distribution of computer reports only to authorized personnel.
    c. Destruction of undistributed reports containing sensitive data.
3. Data Administrator's Responsibility
    a. Insure that security levels are incorporated into the data base structure.
    b. Consider the physical security of the data medium and computer hardware.
    c. Insure adequate backup and error recovery procedures are established and maintained.
    d. Enforce the agreed upon security policies and procedures.

DATA MAINTAINABILITY

The next functional impact of Data Administration on data related activities to be discussed is data maintainability. Maintainability may be considered from two points of view.

1. Maintainability of data is a function of the specific DBMS in use. In this context, maintainability includes a diversity of factors: maintainability of the data; maintainability of pointers; endices, or other internal schemes used to establish data relationships, or maintainability as a measure of physical storage requirements and access capability.
2. Maintainability embodies the concept of flexibility--the capability for modifications to meet changing conditions. The major responsibility of the Data Administrator regarding maintainability are to be aware of the dynamic nature of user requirements, and to anticipate these needs by designing data base to facilitate changes. The Data Administrator must encourage the user community to participate in this "design for flexibility" by advancing planning.

The UAB approached the first concept of maintainability primary by providing technical education and experience for the people responsible for technical support. There is, of course, no substitute for experience. On the job disasters have provided invaluable education and experience to our technical people in two areas: First, we've learned alot of things not to do and how to provide maximum flexibility in back-out and error recovery. Second, painful experience has taught us that under the worst conditions we can unscramble pointers. We feel comfortable with our technical competentency in data base maintainability.

The UAB approached the second concept of maintainability by facing our inexperience in designing data bases with the capability to meet changing user needs. We plan to fill in this gap of experience by utilizing the expertise of consultants who have proven experience in this area.

D. FUNCTIONAL RESPONSIBILITY OF THE DATA BASE ADMINISTRATOR

The functional responsibilities of the data base administrator in the management of the physical data resource at UAB is currently performed by a three person group.

D.1 IMPLEMENTATION AND MAINTENANCE OF MANAGEMENT TOOLS

The UAB Data Base Administration function is responsible for the generation, maintenance, performance, and reliability of IMS, CICS, and the Data Dictionary System. The rationale for including CICS in this area is that CICS is presently our telecommunications access method for IMS. Additional software tools which are incorporated in or sustain these major tools are supported by this group. These include the selection/design of randomizing modules; preprocessor programs for updating the data dictionary system; and the use and maintenance of various CICS and IMS field developed programs.

The Data Base Administration function routinely evaluates the performance of the various IMS access methods in relation to processing types. In addition, selected parameters of in-house data bases are re-evaluated on a routine basis to insure that optimum processing efficiency is maintained.

D.2 PROGRAMMER CONSULTATION AND EDUCATION

The Data Base Administrative group provides technical consultation and education to the administrative programming staff in the areas of CICS and

IMS program implementation, data base design, program performance and program debugging. Two extensive IMS courses were taught by this group to the Information Systems Programming staff. A Data Base Design course was directed toward the Systems Analyst. This was a 60 hour course of lecture plus labs. It included sub-topics of IMS access method program performance, and logical relationships.

An IMS application class was oriented toward the application programmers. This course was 30 hours of lecture plus labs. It included material on the types of IMS calls, program languages consideration and program performance.

D.3 INCORPORATION OF POLICIES AND PROCEDURES INTERPRETED BY THE DATA BASE ADMINISTRATOR INTO THE PHYSICAL DATA RESOURCE.

Data Base Administration is responsible for all data base designs. Much of the data base design for a given application is done by the responsible systems analyst of the application. However, this design is regularly reviewed with Data Base Administration in various stages of the development. The final data base design must be approved by the Data Base Administrator. In addition, all control block generations (DBD's, PSB's, etc.) are the responsibility of Data Base Administrator and are not implemented by the programming staff. Confining these activities to a single group maintains and sustains centralized control of the physical data resource.

PROVISION OF TECHNICAL CONSULTATION TO THE DATA ADMINISTRATOR

Technical implementation of policies and procedures represent follow-through of organizational decisions. There is and must be a close working relationship between the Data Administrator and the Data Base Administrator.

Policies and procedure in relation to the data resource which are technically impossible to implement are only words. Therefore, the technical feasibility or follow-through of the data resource organizational decisions are a continuing discussion between the Data Administrator and the Data Base Administrator.

IV. SUMMARY

The Data Administration philosophy implemented at UAB has been successful. This function has provided a voice for the Administrative User Community to Institutional Management. This communication interface has been effective in meeting the needs of the users in a more orderly and timely fashion.

There were some unanticipated benefits which resulted from the implementation of the Data Administration function. Because our philosophy requires considerable input from the user environment, the users become more involved in the design of the application. Each user in the group perceived that they had gained control in the data decision-making process. This resulted in the users perception that the new Payroll/Personnel System was "their system" not the Data Processing Department's system.

"Fear of loss of data control and decision making input" by the user community has been a concern frequently expressed by organizations when considering the implementation of Data Administration function. Our experience at UAB in the implementation of the Data Administration function proved the contrary to be true. Perhaps, this concern should be reviewed in a new light by other organizations contemplating such an implementation.

MANAGEMENT REPORTING:
AN APPLICATION FOR COMPUTER GRAPHICS

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With increasingly large quantities of management-oriented information being produced for decision-making, administrators are finding that they have insufficient time to adequately review and digest its meaning. The use of the computer has largely contributed to this massive quantity of information production. However, computer-driven systems should have the ability to aggregate, summarize, and present information concisely and comprehensively. This paper will discuss the development of a computerized graphics system that will permit nearly all types of management information to be displayed in graphic form. Graphic information is more understandable and helps take the drudgery out of the information review process. This paper will discuss the motive and approach for systems development along with specific applications for higher education institutions.

MANAGEMENT REPORTING: AN APPLICATION FOR COMPUTER GRAPHICS

INTRODUCTION

In recent years much attention has been given to management reporting in higher education institutions. Administrators are being plagued with voluminous amounts of data which purports to assist their understanding of the nature and operation of the institution. Information systems have typically produced large quantities of information so as to better support the decision-making role of administrators. The increasing complexity of higher education processes and volumes of data dictate the use of the computer to achieve comprehensive, indepth reporting. The result, however, has been an excess of computer output that is useful for review and analysis. This data explosion has resulted in much useful information falling by the wayside due to the lack of time and energy for proper digestion by the institution's administrators, managers, executives or other decision-makers.

Little relief from this data explosion is anticipated. Increased emphases on the management of higher education dictate an increase in the volume of necessary information. However, no matter how many computer-generated reports are available, they have little, if any, value unless they can be presented in useable form to the decision-maker. Information must be comprehensible. Graphical representation of data enhances comprehension and the translation of data to information and intelligence. The advantage of graphics is that the data can be communicated to the administrator in more comprehensible, intelligible, and, hopefully, useable ways than by conventional reporting paradigms.

Too many reports are hastily reviewed by the administrator without real visual understanding of the results. To extract required information and meaning from tabulated raw data, one must analyze the numbers and make the required translations. Computer graphics can systematically accomplish this in a more rapid and accurate fashion than human processes. In addition to addressing the problems of volume and basic comprehension of certain data, computer graphics can deepen the administrator's understanding of realities which the data represents than would otherwise be possible.

Not all information is conducive to graphics presentation. However, those research findings and managerial reports that use it should require less time and energy by the busy administrator to absorb the data and their meaning. Thus, insight to decisions can be achieved with minimal confusion which normally arises out of poor data formats and contextual misunderstandings. Rather than spending the time on "what do the numbers in the table say?" administrators, with the use of graphics, will more readily arrive at "how should I respond to the situation?"

DESIGN CONSIDERATIONS

Graphic reporting systems must be designed with essential support from "known" hardware and software systems. Design begins with hardware/software support one currently has (or expect to have by implementation time). This includes a plotting device, computer and software to process data and drive the device, and procedures that make this configuration functional.

Computer graphics products may be produced in either an off-line or on-line mode. Historically the off-line approach has been more popular due primarily to trends in the evolving development of graphics technology. On-line systems are becoming more attractive due to recent advances in graphic display terminals by way of lower costs and increased plotting versatility. It doesn't matter which plotting mode one uses, assuming the basic components are in place, the task is to design a system to transform management information, research findings, or raw data to graphical representations.

Many computer graphics systems have been developed to produce specific graphs for specific purposes. Often these systems lack the flexibility to support a broad range of information needs normally required by the user. The Penn State Management Graphics System (MGS) was designed to accept a variety of data types, (via a free format mode) interact with existing information-producing computer systems, and produce a variety of output displays. It was felt that the degree of acceptance of the system by the user would be based on how successfully these objectives would be incorporated into the final system design.

The overall design consisted of two major modules: (1) compilation and summarization of data from magnetic files and (2) the analysis and preparation of that data for external display. These separate modules were defined so that an operational distinction could be made between these two very different functions. Further sub-modules were defined for clearer definition of specific functional processing such as analyzing the incoming data stream, calculating graph sizes and component relationships, and determining positions of labels, titles, and comments. The modular design approach also facilitates multiple data-entry into the system. Thus, data for graphics display can be prepared from existing computer files, completed reports, or even from working notes.

Nature of Information

Initial design efforts involved a study to understand the nature of information as used by decision-makers so that the system would accommodate a variety of data types and information relationships. From this investigation, we identified the basic components of management information to be characterized as "what" and "how much." These two elements are necessary to "identify and quantify" data. As we apply these two items successively, we can depict relationships for graphic representation. The presentation of similar relationships in a successive manner should then represent meaningful information. Figure I illustrates how one might graphically show comparisons of "what" and "how much."

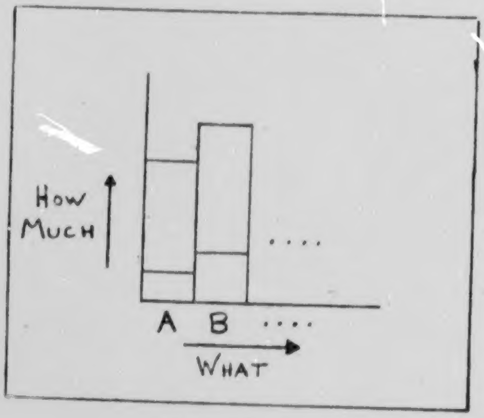


Figure I

For example, consider the following four questions:

1. How many students are enrolled at Institution A?
2. How many faculty teach at Institution A?
3. How many students are enrolled at Institution B?
4. How many faculty teach at Institution B?

Question I, in and of itself, has limited graphic value. If we combine question I and 2, some information emerges--namely, a student/faculty ratio. Likewise, if we graph this relationship for several similar institutions, as in Figure I, we can make a visual comparison of student enrollment, faculty, and student/faculty ratios among these institutions. By further qualifying these questions to consider only students and faculty in specific academic programs, the informational value of these graphs will improve significantly. This perception of information influenced subsequent design decisions.

Display Types

Academic administrators at all levels need to understand trends, distributions, and comparisons of many institutional phenomena and characteristics. Some examples are: distribution of faculty time among the various professional activities; comparative trends on enrollments among the various academic programs in the institutions; average section size of certain (any) courses; comparison of one academic unit with the institutional averages; comparison of average faculty teaching load among selected departments; and many more.

MGS was designed to generate pie graphs, histograms, and line graphs to support these kinds of information needs. These graphs can be used to show trends over time, comparisons between similar outcomes, and item distributions. These three display options accommodate most types of management-oriented information.

Operational Aspects

The MGS produces its output either off-line or on-line. The main computer summarizes and analyzes data and prepares a magnetic tape for the off-line plotting by a smaller computer. This relatively slower process of actual graph production is more economically handled by a slower, less expensive machine. For the off-line production mode, plot time calculations and procedural feedback loops to the user were defined to control this operational activity.

The on-line mode of operation requires a graphic display terminal to be connected to the main computer. In this mode, the graphics requests can be initiated from the terminal and the resulting display produced immediately.

Considerable effort was made to interface with existing computer systems. Output from these systems is customarily produced in tabulated form. Thus, it was necessary to examine the reformatting requirements to have this tabulated data passed to the MGS with a minimum of program modifications. This programming change to existing computer systems usually resulted in an "add-on" subroutine that prepared data for the graphics display module.

In addition, it is important to have the manual data preparation chore as natural and straight forward as possible. Often when a system provides several options and extensive flexibility, its data can only be prepared by a technician who is familiar with the inner workings of the system. To help insure wider acceptance and use of the system, it was desirable to have simplified rules for data preparation.

SYSTEM CAPABILITIES

A primary consideration in designing computer base systems is to maximize flexibility and user options while minimizing the drudgery for the user in communicating his options to the system. A system that is characterized by a few well-designed capabilities with nominal input requirements will be used more than the "do everything" system that has a long list of special rules required for its use. Options are communicated to the MGS with few format rules and are designed to provide substantial flexibility to the user in formulating appropriate display types and descriptions.

Options

Pie graphs, line graphs, and histograms represent the most common graphs used in business applications. The users may choose any of these three types for his data display. To determine the one that should be selected, one must consider the relationships of the data and what meaning is to be derived from them. Pie graphs show distributions and the relationships of parts to the whole. Line graphs effectively show trends over time, while histograms are useful in showing relational status at a given point in time.

The line graph and histogram may be used to display several "levels" of information simultaneously. This option will produce several lines on one graph or segmented bars on the histogram. In this way several comparisons can be analyzed on the same graph.

The user may formulate the title and comments for each of his graphs. These should describe such things as data source, information time frame, and other factors that will clarify the meaning of the display. Titles will be centered beneath each graph and comments are listed near the bottom left margin.

For the line graph and histogram, categories are noted along the horizonal axis (in Figure 1, A and B represent categories). The value associated with each category is plotted and referenced to a vertical scale. There are no restrictions on these values since appropriate internal scaling is calculated for "best fit" on the output graph.

Some graphs may be used for reports or maintained in "working folders" for subsequent referral and study. Other graphs may be used for presentations or for wall displays. This system will permit the user to select various graph sizes ranging from an 8 1/2" x 11" to approximately 22" by 32".

The user who does not have a graphics display terminal and wishes to have immediate response for graphics displays may request a printer-produced histogram. This eliminates the "wait" time required for normal off-line plotting. Appropriate internal calculations are made for scaling and positioning the histogram on the printed page. Figure 2 illustrates an example of a printer-produced histogram.

Other options include a grid for the line graph and provision to identify the various display levels (for the line graph and histogram) through the use of comments. In addition, individual lines of a multi-line graph may be identified with appropriate labels printed near the end of each line.

Grouping

Often information cannot be effectively displayed in one graph to show the desired relationships among its components. By producing several graphs and employing the use of the size option, the MGS can generate a series of graphs to facilitate visual comparisons.

For example, the grouping option may be used to compare the distribution of faculty by rank of several colleges within the institution against a corresponding distribution of all faculty in the institution. For this example, the rank distribution of all faculty would be displayed via a large pie graph and the smaller pie graphs for each college would be positioned appropriately around it.

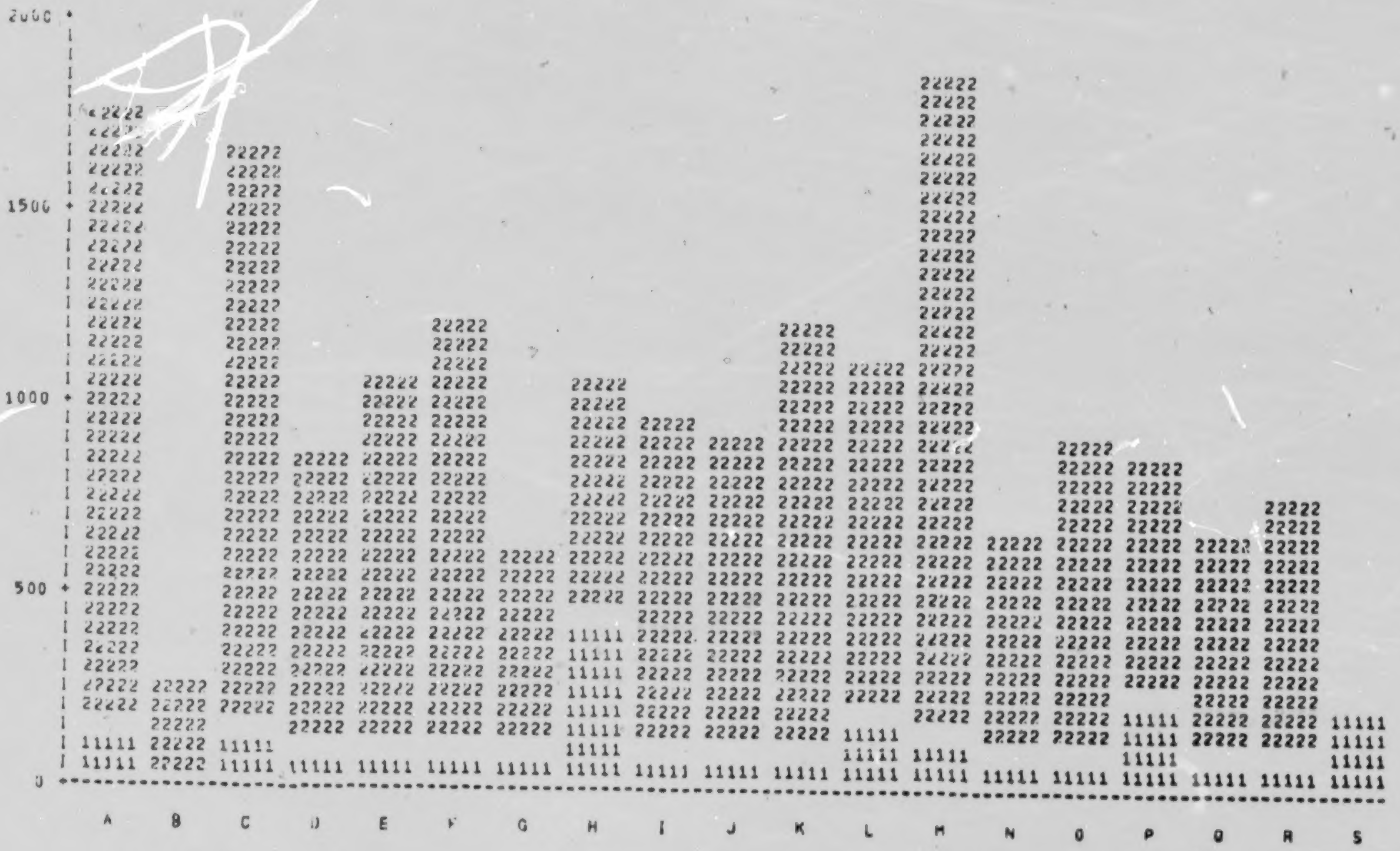
Free Format

When data are prepared manually, all options are communicated to the

MANAGEMENT GRAPHICS SYSTEM

DATE: 11/18/76

GRAPH 1



PART TIME VERSUS FULL TIME ENROLLMENTS
FALL TERM 1975

COMMENTS:
LEVEL 1 = PART TIME
LEVEL 2 = FULL TIME

Figure 2

system by coding in a "free format" mode. The "key word" concept is used so a natural left-to-right keying procedure can be used. It also eliminates the need for a specific ordering of the data items.

Figure 3 represents a request for a pie graph with 5 categories to be plotted on page-size paper (8 1/2" x 11"). The graph will illustrate a distribution of faculty rank for a given college.

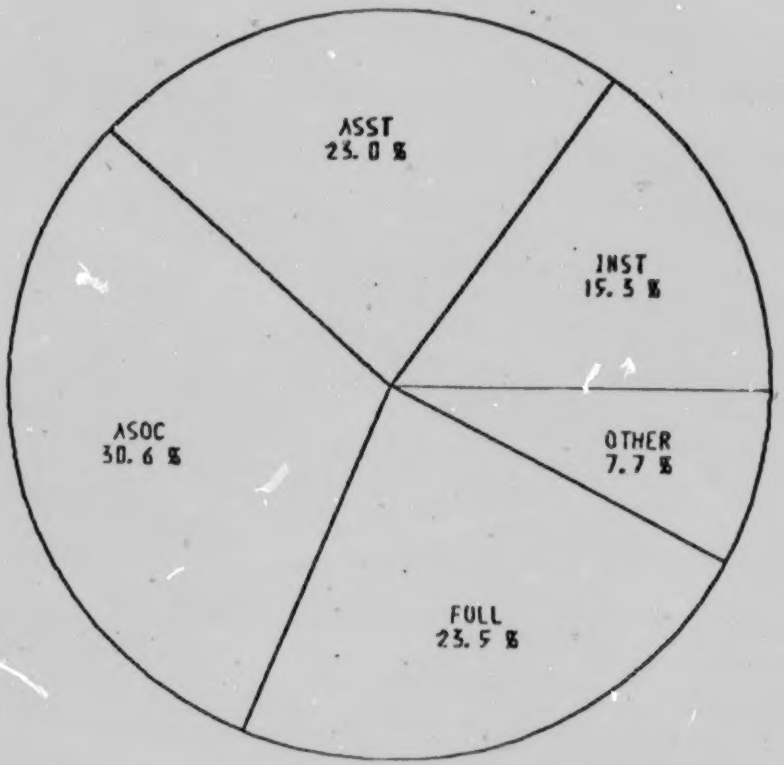
```
1, TYPE = PIE, SIZE = PAGE, CAT = 5
2, FACULTY RANK DISTRIBUTION FOR COLLEGE A
3, AS OF 9/30/76
4, INST, 60, ASST, 90, ASOC, 120, FULL, 92, OTHER, 30
```

Figure 3

The "1" line identifies the options that are to be used for the display. The "2" line identifies the title for the display and the "4" line contains the data that are to be plotted. Comments for this display are noted on the "3" line. Figure 4 represents the resulting display.

Data Sources for Graphic Display

Existing computer systems can readily adjust to the data formatting requirements of the MGS. With minor modification, these systems can use the MGS to produce graphic output that compliments their standard production reports. Normally the addition of a subroutine to the existing system will provide the necessary linkage to the display module of MGS. It is not the intent to have the MGS displays replace existing reports produced by these



FACULTY RANK DISTRIBUTION FOR COLLEGE A

AS OF 9/30/76

Figure 4

systems (although this may happen), but rather to provide the option to review the information via a graphical representation. Each existing computer reporting system is a potential candidate to use the MGS.

New information systems and institutional studies can, by initial design, incorporate the MGS capabilities for information display. Knowledge of its capabilities may assist in the design of meaningful output to depict the required outcomes.

Another source of data for graphics display is the numerous reports that have already been produced. To obtain a "new look" at these reports, data can be extracted and formatted for processing by the MGS. This manual process would result in producing a graphics request similar to the one shown in figure 3. In generating graphs from existing reports, one can select any of the available graphic displays and options.

Operations Control

Since the MGS processes graphic requests serially, there is no limit to the number of graphs that can be produced at one time. Graphic request data is accepted in any combination of types and groupings. The control variable is the "plot time" for final graph production. In the off-line mode the plot time for twelve graphs is forty minutes. With an on-line graphic terminal, twelve graphs would take approximately seventy-five minutes. The on-line plot time would be dependent on the type of graphics terminal used.

As part of operations control, the MGS generates a control document for each grpah. This document identifies what options were selected, numeric values on the graph, labels, titles, comments, and an estimated plot time. It can be used to identify what graphs are being produced, assist scheduling off-line plotting time, and as a detailed record of total graphic production. Figure 5 shows an example of this document for one graph.

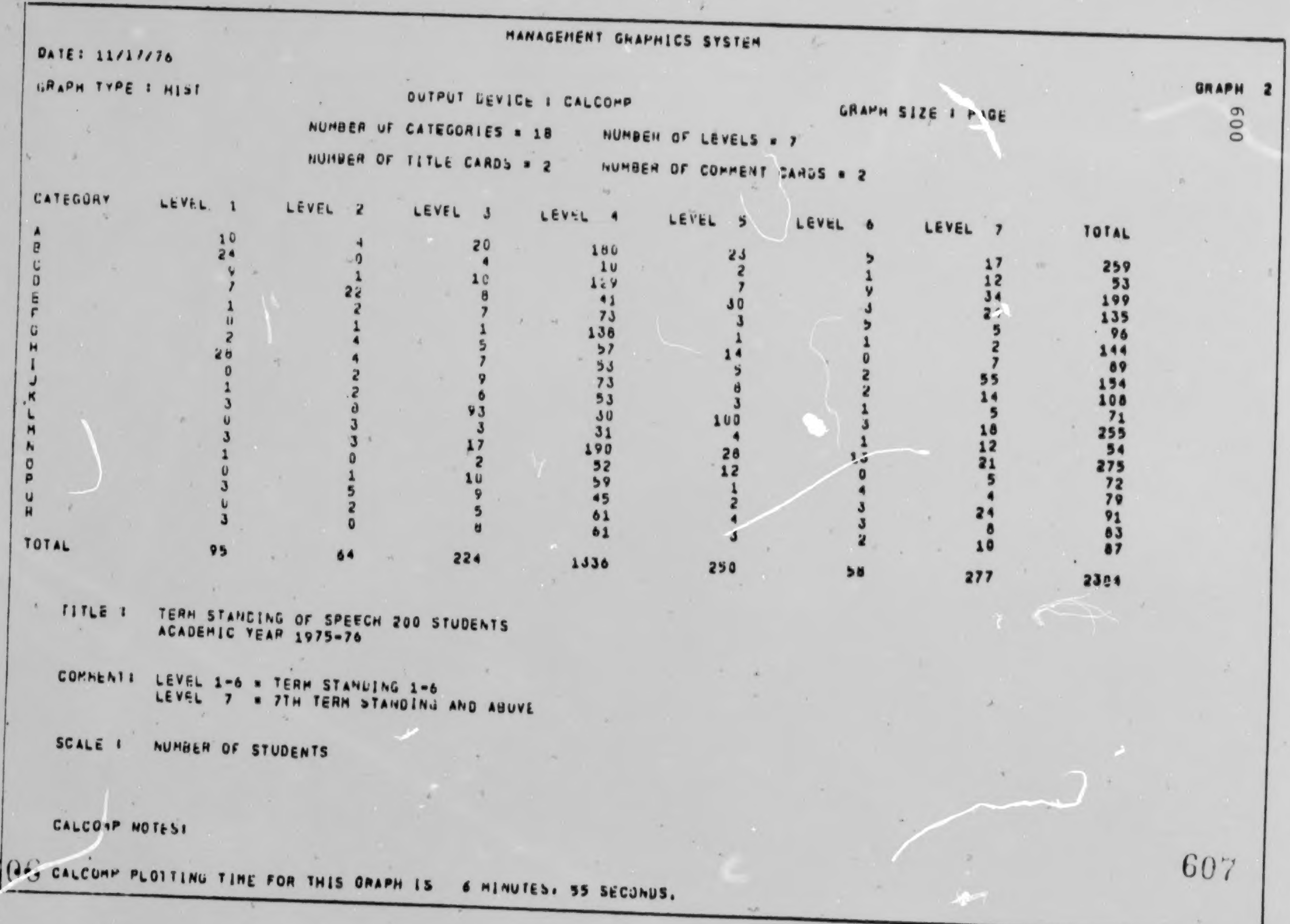
SOME EXAMPLES

Figures 6 through 11 illustrate examples of available graphic displays. These graphs show the various display options available from the MGS and how they might be used to represent pertinent information. In some cases, graphs were reduced for printing purposes.

The pie graph in figure 6 shows a distribution, by age group, of tenured faculty. This distribution pattern could be compared to similar graphs of specific colleges within the university. Graphs of this type could be used to support institutional tenure studies.

Figure 7 shows the "average" distribution of how the typical faculty member in college B spends his/her professional time. Comments are used to define the abbreviated labels in the pie sectors. The information revealed by this graph may raise questions regarding the ratio of class preparation hours to class contact hours. Also, one could discuss with the college dean the significance of the difference between "RES NBGT" and "ORG RES".

Figure 8 and 9 show enrollment trends - historic and projected respectively. The multiple lines effectively show trends of various subgroups and how they influence the total. Seven lines may be plotted simultaneously. The labels at the line extremities are optional. These may appear as comments at the lower left portion of the graph. The grid



```
                                  MANAGEMENT GRAPHICS SYSTEM
DATE: 11/17/76

GRAPH TYPE : HIST                                                                                   GRAPH  2
                            OUTPUT DEVICE : CALCOMP                    GRAPH SIZE : PAGE
                  NUMBER OF CATEGORIES = 18     NUMBER OF LEVELS = 7
                  NUMBER OF TITLE CARDS = 2     NUMBER OF COMMENT CARDS = 2

CATEGORY     LEVEL  1   LEVEL  2   LEVEL  3   LEVEL  4   LEVEL  5   LEVEL  6   LEVEL  7     TOTAL
A                  10          4         20        180         23          5         17       259
B                  24          0          4         10          2          1         12        53
C                   9          1         10        129          7          9         34       199
D                   7         22          8         41         30          3         24       135
E                   1          2          7         73          3          5          5        96
F                   0          1          1        138          1          1          2       144
G                   2          4          5         57         14          0          7        89
H                  28          4          7         53          5          2         55       154
I                   0          2          9         73          8          2         14       108
J                   1          2          6         53          3          1          5        71
K                   3          8         93         30        100          3         18       255
L                   0          3          3         31          4          1         12        54
M                   3          3         17        190         28         13         21       275
N                   1          0          2         52         12          0          5        72
O                   0          1         10         59          1          4          4        79
P                   3          5          9         45          2          3         24        91
Q                   0          2          5         61          4          3          8        83
R                   3          0          8         61          3          2         10        87
TOTAL              95         64        224       1336        250         58        277      2304

     TITLE :   TERM STANDING OF SPEECH 200 STUDENTS
               ACADEMIC YEAR 1975-76

     COMMENT:  LEVEL 1-6 = TERM STANDING 1-6
               LEVEL  7  = 7TH TERM STANDING AND ABOVE

     SCALE :   NUMBER OF STUDENTS


     CALCOMP NOTES:

     CALCOMP PLOTTING TIME FOR THIS GRAPH IS   6 MINUTES, 55 SECONDS.
```

Figure 5

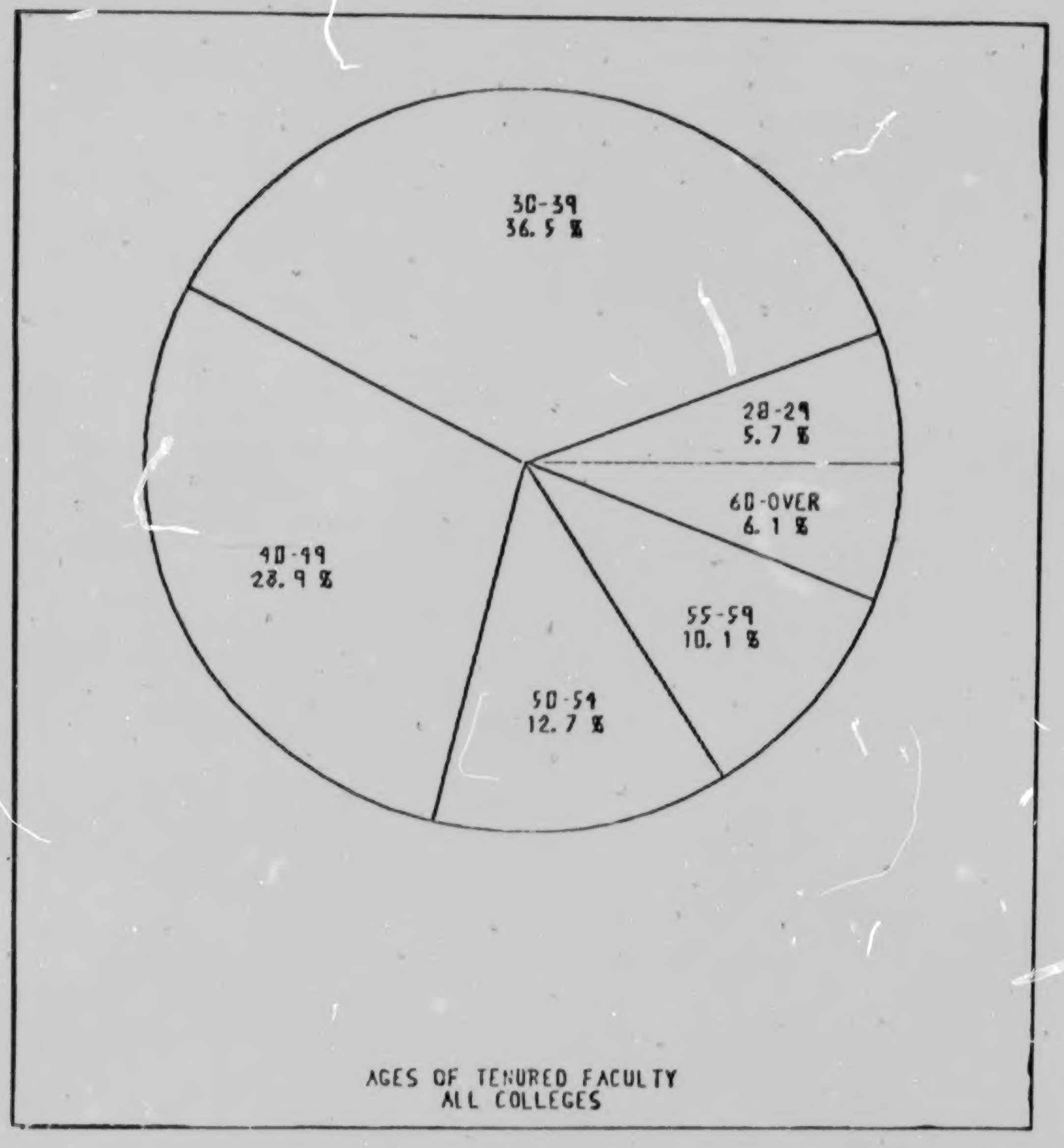
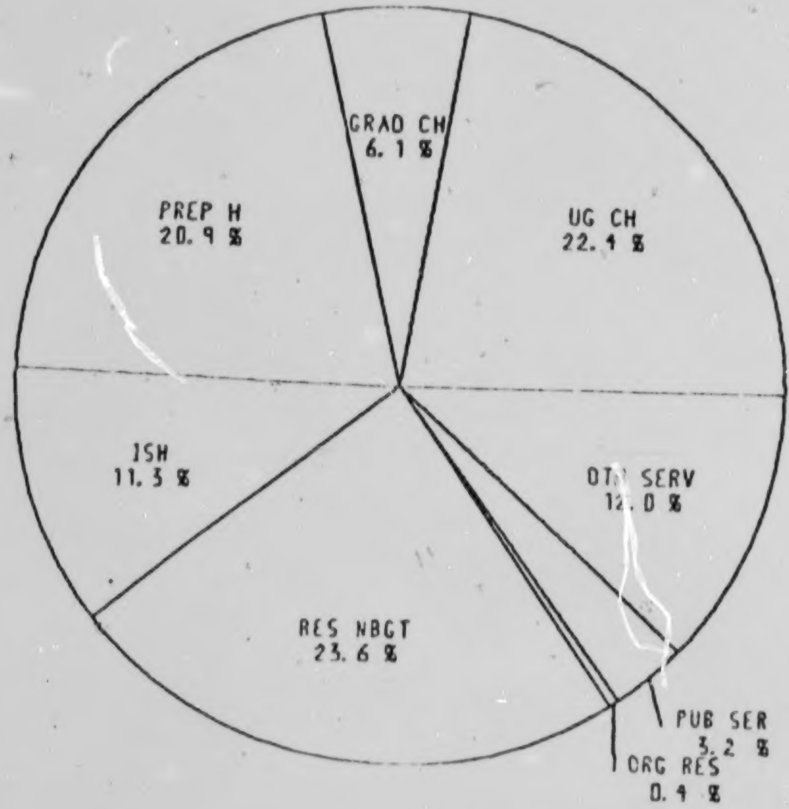

30-39
36.5 %
20-29
5.7 %
60-OVER
6.1 %
55-59
10.1 %
50-54
12.7 %
40-49
28.9 %
AGES OF TENURED FACULTY
ALL COLLEGES

Figure 6

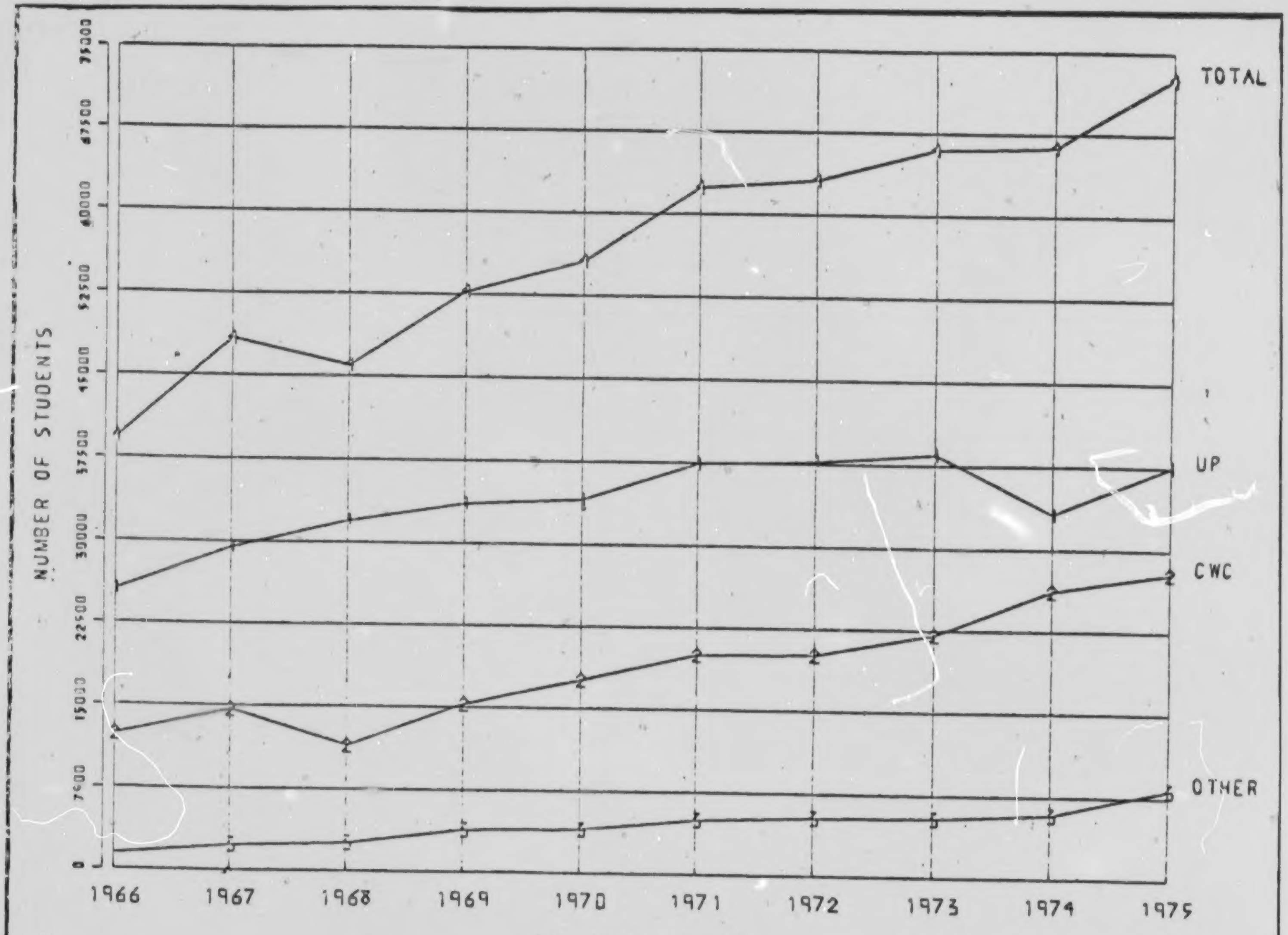


FACULTY ACTIVITY
COLLEGE B

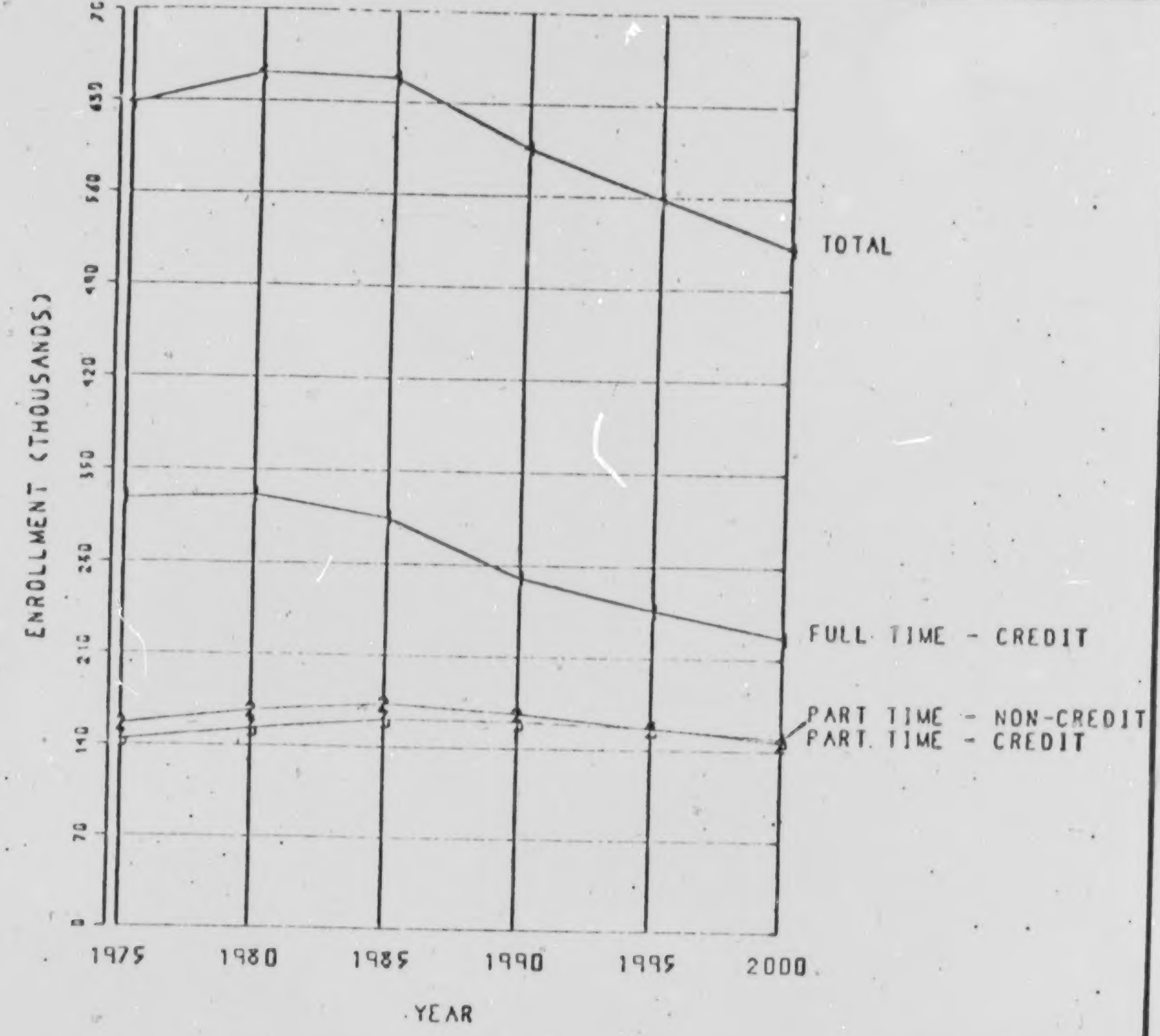
UG CH - UNDERGRADUATE CONTACT HOURS
GRAD CH - GRADUATE CONTACT HOURS
PREP H - PREP HOURS
ISH - INSTRUCT SUPPORT HOURS
RES NBGT - RESEARCH NOT SEPERATELY BUDGETED
ORG RES - ORGANIZED RESEARCH
PUB SERV - PUBLIC SERVICES

Figure 7

Figure 8



PSU ENROLLMENTS
ALL RESIDENT AND NON-CREDIT COURSES



HEAD COUNT ENROLLMENT BY ATTENDANCE STATUS AND TYPE OF ACTIVITY

Figure 9

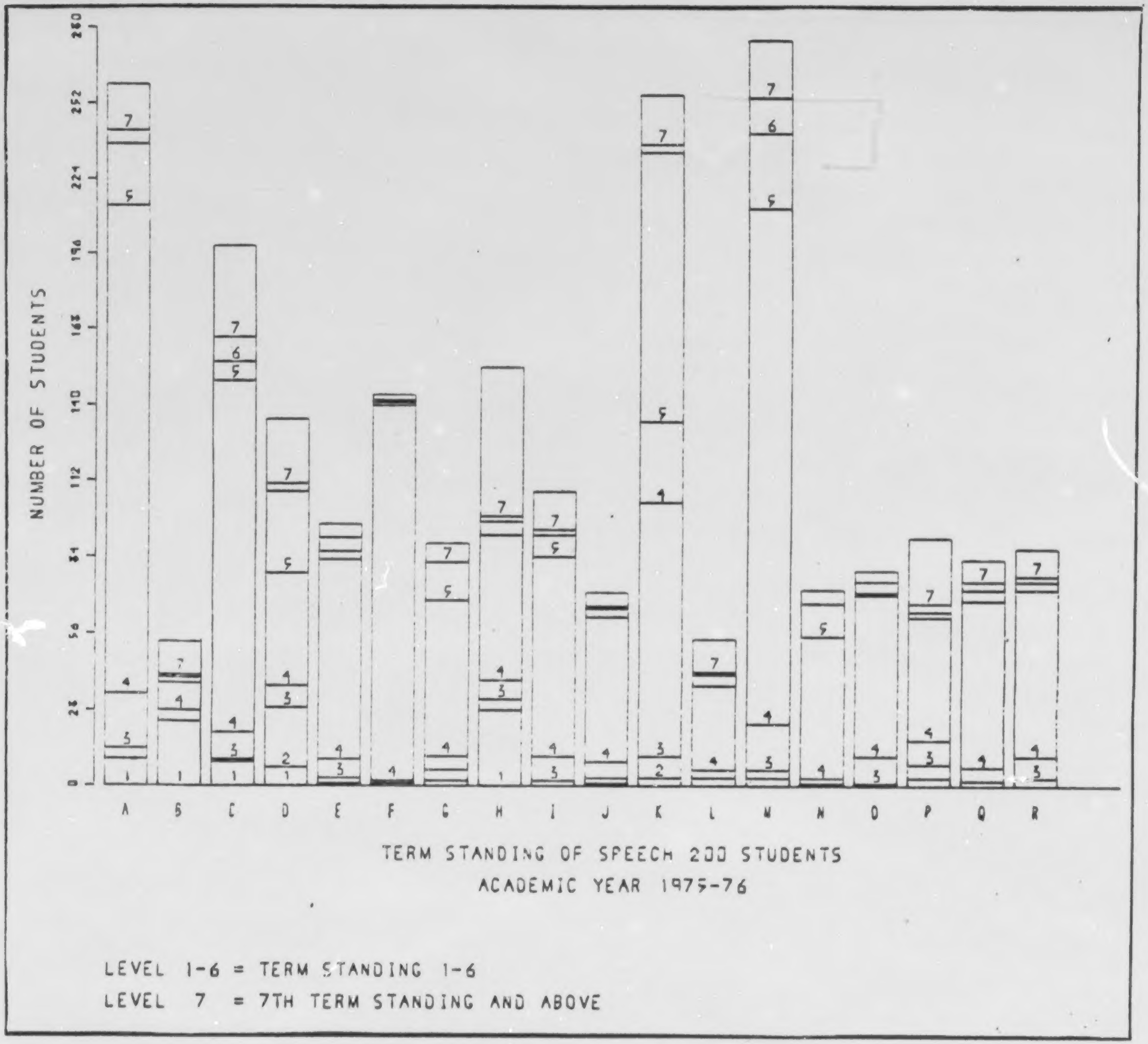
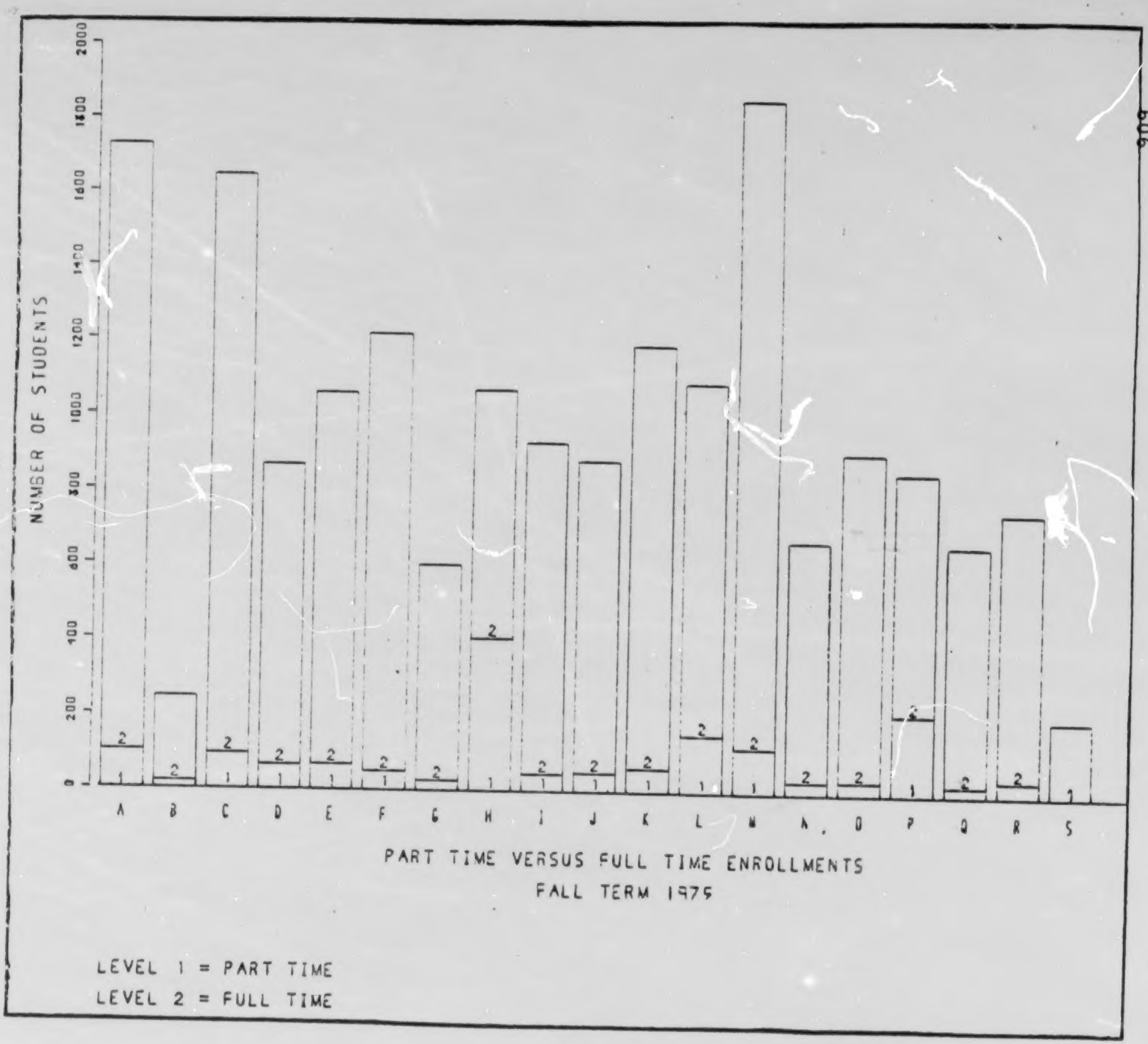

NUMBER OF STUDENTS
0
28
56
84
112
140
168
196
224
252
280
A
B
C
D
E
F
G
H
I
J
K
L
M
N
O
P
Q
R
TERM STANDING OF SPEECH 200 STUDENTS
ACADEMIC YEAR 1975-76
LEVEL 1-6 = TERM STANDING 1-6
LEVEL 7 = 7TH TERM STANDING AND ABOVE

Figure 10

Figure 11



PART TIME VERSUS FULL TIME ENROLLMENTS
FALL TERM 1975

LEVEL 1 = PART TIME
LEVEL 2 = FULL TIME

is also optional. However, its use assists the viewer in identifying increases or decreases over specified intervals.

Figure 10 shows the number of students who took speech 200 at campus locations A-R during the Academic Year 1975-76. Each bar is segmented to group the students by term standing. Since the course is designed to be offered to fourth term students, one can review the offering pattern of the course at each campus and determine if most of its students are in fact taking this course during their fourth term. Campus F shows the most desirable student-scheduling pattern for speech 200.

Figure 11 illustrates the ratio of part-time students to full-time students at the various campus locations. This graph readily shows "undesired" proportions that may exist--such as the approximate 40% part-time count at Campus H.

These examples illustrate just a few of the numerous applications areas that might use graphics to display management information. Those graphs that prove to be particularly useful may be "programmed" to be part of the standard output of the reporting system.

CONCLUSION

As decison makers in today's institutions are called upon to review and digest more and more information, it becomes imperative to devise methods and techniques that will assist the administrator in understanding what is reported. Computer graphics can play a significant role in removing much of the drudgery in analyzing reports. The MGS is an attempt to minimize confusion and time in the information review process.

The adaptability of the MGS to existing computer systems and its ability to accept data from historical reports has proven to be useful qualities. Often management information is best preserved in graphics form. In this way, subsequent review and understanding is more readily accomplished.

Future efforts will no doubt involve an extension of the capability to serve a broader segment of academic administration. As the use of graphics terminals becomes more wide spread, development could move into the interactive graphics arena to explore the potential for answering "what if" type questions. This would be particularly useful during this period in higher education when problems such as program re-evaluation, budgeting reallocations, and changing enrollment patterns must be confronted.

Graphics may not be a panacea for management information reporting. However, since it is not complicated by numeric tabulation, the busy administrator can better grasp its true meaning. Thus, he can spend more time deciding what his alternatives should be rather than interpreting the data. Those information systems employing graphics will most likely be more popular and will no doubt be called upon regularly to provide information to the decision maker.

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THE DESIGN AND MANAGEMENT OF A UNIVERSITY FINANCIAL DATA SYSTEM

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Clemson University has recently developed a financial information system that serves as a focal point for all accounting, budgeting, and grant data. The system, designed along NACUBO guidelines, records all data in a data base used to generate financial information in a batch and an on-line mode. The software design is such that the system can be transferred to other institutions having a different data base management system. This paper describes the daily operation of the system from a financial management as well as a data processing perspective.

THE DESIGN AND MANAGEMENT OF A UNIVERSITY FINANCIAL DATA SYSTEM

I. AN INTRODUCTION TO CLEMSON UNIVERSITY

Clemson University is a land-grant, state supported institution near the mountains of South Carolina. It was founded in 1889 as the result of a bequest by Thomas G. Clemson, son-in-law of John C. Calhoun, a former South Carolina statesman and Vice President of the United States during 1825-1832. Clemson was originally Clemson Agricultural College, and became Clemson University in 1964.

There are nine colleges on the main campus which contains 600 acres and represents an investment of approximately $125 million in permanent facilities. In addition to the main campus in Clemson, South Carolina, there are about 32,000 acres of farms, woodlands, and camp areas that are used for research in agriculture, forestry, and 4-H work.

Clemson has in excess of 10,000 students and a biweekly payroll of over $1.7 million for 5,000 employees. During fiscal 1975-76 our current funds operating budget was approximately $69,248.00.

II. DATA PROCESSING FACILITIES AND ORGANIZATION

The Computer Center serves the academic, research, and administrative needs of the University. In order to meet these needs, we have an IBM 370/158 computer with 3 megabytes of main storage. Additionally, we have 4800 megabytes of storage on 26 CALCOMP 235-11 disk drives. This hardware is interfaced with the users through OS/VS2 release 1.7.

We have approximately 170 CRT terminals which are managed by TSO. During March, 1976, we processed 4,010 batch jobs in one day; our daily average is 3500. The administrative applications comprise approximately 23% of our daily work load.

We are presently in the process of upgrading our hardware to an IBM 370/165-2 with 4 megabytes of main storage, which will provide three times the power we presently have.

The Division of Administrative Programming Services (DAPS) was organized in July, 1974, and its purpose is to serve the administrative functions of the University in the areas of new systems development and systems maintenance.

We have three programming teams: one for the business office, one for student applications, and one for other administrative areas. Each has a team chief and consists of approximately 5-10 programmers and analysts. Each individual system has a project leader and a backup project leader and utilizes other programmers as needed.

In July, 1974, shortly after the Division of Administrative Programming Services was formed, we began the detail design of DAPS' first major project, an Expenditure Accounting System. During the process of this development, we progressed from an Expenditure Accounting System to a General Ledger System and finally to our end result which is the subject of this paper: the Accounting Information System.

III. DESIGN AND DEVELOPMENT

A. SYSTEM DESIGN

Exhibit III-1 shows the components of the daily operation of the Accounting Information System. The structure is such that one step must be completed before the next step(s) can be run. Thus, a new account number must be added to the data base during the account maintenance step so that budget or encumbrance data can be added in subsequent steps.

The Accounting Information System is designed in a modular fashion and is coded in structured programming. All programs are written in a clear, straightforward manner in ANS COBOL. The data base management system is IDMS, which is based upon the specifications of the CODASYL Data Base Task Group.

All data base access is executed through called modules. The system is designed so that it can be transferred to other institutions having a similar application, but possibly different file management software.

B. PROGRAMMING APPROACH

Several members of the systems development group have attended schools on and experimented with structured programming. Almost all members of the staff have experience in modular programming. It was determined that this project would use those techniques associated with structured programming. The following techniques were employed:

Top-Down Design. Each major sub-system (such as budget maintenance) is broken down into smaller functions (such as read transaction, edit transaction, apply change update, generate report record, etc.). These functions in turn break into smaller functions (open file, call generalized date edit, etc.).

Highly Modular Design. Each module accomplishes usually one major task (edit account number, write accounting transaction, etc.) Each sub-system has a mainline module that drives the activity necessary by calling lower level modules, which may in turn call still other modules. The completed system has 350 modules that are linked into 40 composite modules.

Mostly Structured Code. The basics of structured programming were used with very few exceptions. It was discovered that, after orientation, programmers were able to read other programmer's code quite easily and were able to produce clear, readable modules in a very favorable time period. Also, maintenance of the system has proven easier than that of some of our more traditional systems.

Walk-Throughs. All programmers presented the most critical modules in walk-through sessions. These served as an incentive for the programmer to write clear and readable code and also served to catch many major errors bedore modules were unit tested. It was noted that the presence of higher level managers at the sessions tended to suppress participation and thus cause less real accomplishment.

Top-Down Implementation. Using this technique, testing of higher level modules was done before lower level modules were even coded. 'Stub' modules that displayed a trace code were inserted in composite modules so that calling modules could be tested.

Librarian. A project librarian was used to maintain all COBOL 'copy code' and to notify programmers of changes in this code during the design phase. Each programmer maintained the source modules that she/he was assigned by using the TSO Edit facility. At project implementation, all modules were put in a production library. These production modules are not changed by the programmer, but are replaced by the librarian when the programmer has tested a change using other libraries and the project leader has notified the librarian that the replacement should be made.

C. MANPOWER REQUIREMENTS AND OPERATIONAL CHARACTERISTICS

The general design of the system was completed in six calendar months, and the detail design, coding, and testing were done in about five calendar months of intense effort with a team of eight programmers. The total effort represented an investment of five programmer/analyst years and two manager years.

The daily portion of the system runs an average of four CPU minutes on an IBM 370/158. The elapsed time varies depending upon conditions from ten minutes to ninety minutes. The monthly data base reporting and maintenance requires about fifteen CPU minutes and runs about ninety minutes elapsed time.

The operational results of the system have been very good. All financial reports have been correct and in balance, and only four errors in production modules have been discovered to date. Also, the fact that the system is designed in a modular fashion has greatly facilitated the maintenance effort.

D. FEATURES OF THE SYSTEM

1. A diagram of the Accounting Information System data base is shown in Exhibit III-2 and shows the "set" relationships of the 13 record types. The record types are:

1-6	Debit/Credit Accounting Transactions
7	Account Master
8	Encumbrances
9	Expenditure Budget Accounts

10 Fiscal Year/Project Life Budgets
11 Project Master
12 Revenue/Transfer Accounts Budget
13 Monthly Summaries of Debit/Credit Transactions

Direct access is provided to project records, expenditure budget account records, and detail account master records. Records under these record types are stored physically near their parent records. All the accounts in a given project are members of a "set" and can be referenced directly when given the project identification. Also, all expenditure budget accounts for a project can be referenced in a like manner, and all detail accounts for a given expenditure budget account are in a "set."

2. The System provides for daily updating and maintenance of the data base through batch input. The input can be from either punched cards or generated by other automated systems such as payroll or vendor payments.

   All data is thoroughly edited before being accepted for recording on the data base. If an error is found in any batch of debit/credit transactions, the entire batch is rejected and the error must be corrected in order for that batch of transactions to be posted. An error in any of the other types of transactions will cause that particular transaction to be rejected.

3. The Accounting Information System produces all financial reports required by the University. These reports are produced monthly and/or yearly, and also on demand.

   A report request is entered into the System by keying in the report code name requested and the range of batch numbers and dates to be included. The report data extractor program will then analyze the requests and extract the required information from the data base for each report requested. The extracted data is then sorted and printed by the report supervisor program.

In this fashion, only one pass of the data base is required to generate as many reports as are requested at a time.

4. After all monthly financial statements have been produced and it is determined that the month can be closed, we perform certain data base maintenance functions. These functions include removing all detail debit/credit transaction records and placing them on a history file. These records are also summarized by account number and total records are posted to the data base.

5. On-line inquiry to the data base is supported by the Accounting Information System. All data in the data base can be retrieved, but typically only account summary, budget status, or grant status data is obtained. A detail listing of accounting transactions, budget amendments, or encumbrance data can be obtained for an account or a group of accounts. The organization of the data base permits direct access at the grant, budget, and account number levels.

IV. MANAGEMENT OF THE ACCOUNTING INFORMATION SYSTEM

On July 1, 1975, Clemson University implemented the Accounting Information System which serves as a focal point for all accounting, budgeting, and grant data. In addition, it maintains all historical account data and facilitates all fiscal requirements including encumbrances and salary projections. This portion of the paper focuses on the daily operation and management of this system.

The Accounting Information System embraces the College and University Business Administration accounting principles. There are expansions to allow for the uniqueness of management and operational desirabilities at Clemson University, e.g., Clemson University has chosen to divide both the unrestricted and restricted current funds into additional sub-groups, as follows:

Unrestricted Current Funds -

To account for the current funds which are determined to be within the definition of "Unrestricted," such as federal/state appropriations and general purpose operating revenues.

Unrestricted Current Funds - Auxiliary Enterprises

To account for separate self-supporting entities within the Unrestricted Current Funds, with each having its own self-balancing assets, liabilities and fund balance.

Restricted Current Funds

Grants and Contracts

Scholarships and Student Aid

Other

To account separately for each of the above Restricted Current Funds sub-groups, with each having its own self-balancing assets, liabilities and fund balance.

Fund groups in addition to the current funds are:

Loan Funds

Endowment and Similar Funds

Plant Funds

Agency Funds

A. ACCOUNT NUMBER STRUCTURE

The Accounting Information System is based upon a six field, seventeen digit account number (Exhibit IV.1). The components are as follows:

1. Field 1 of the account number represents the Major Fund Group (Unrestricted Current Funds, Loan Funds, Endowment Funds, Plant Funds, etc.).

2. The second field of the account number indicates the Type of Account (Expenditure, Revenue, Asset, Liability or Fund Balance Account) - (Exhibit IV.2). This field's importance cannot be overstated because Field 2 of the account number determines the reports - both monthly and yearly - upon which the activities of the account will appear. Additionally, Field 2 of the account number determines the coding entries of Field 3.

3. Field 3 further details Field 2 - specifying the Object Class of Expenditures, Detailed Source of Revenue, or the Identification of Assets, Liabilities, Additions and Deductions. For example, if Field 2 of the account number indicates an asset account, Field 3 will specify whether the asset is cash, investments, inventories, etc.

4. Field 4 of the account number is the Department/Unit Identification Number. Every expenditure is charged to a departmental/unit budget. (When Clemson elects to implement a cost prediction model, Field 4 in conjunction with Field 2 will facilitate this undertaking).

5. Field 5 identifies and describes the primary source from which funds were received and expended.

6. Field 6 indicates the smallest breakdown of a Fund Balance. For example, numerous research projects are being conducted in the Agricultural Experiment Station. Field 6 permits the breakdown of these research funds to specific project fund balances.

B. ACCOUNTING CONTROL SECTION

Necessitated by the implementation of the Accounting Information System, a new operational section was established under the Assistant Vice President for Financial Management (Exhibit IV.3). This section, known as Accounting Control, has a Director and a staff of four - one professional position, two quasi-professional positions, and one clerical position. Existence of this section is essential to the operation of the Accounting Information System for controlling the input to the System, thus controlling the output of the System.

Data control and financial reporting are the two primary responsibilities of Accounting Control. All input to the System is channeled through this section, as is all output. Cut-off schedules for the generation of monthly budget status reports are established and coordinated by Accounting Control, as well.

C. BATCH INPUT

The Accounting Information System provides after the fact recording of all accounting transactions at Clemson University. Input to the System comes directly from other automated systems (such as payroll or check writing system) and from manually prepared transactions (such as journal entries). All input, whether manual or automated, is batched. A "batch" is defined to be a collection of transactions that have a specific relationship. There are fifteen different Batch Types utilized in our Accounting Information System (Exhibit IV.4). As you can see, these Batch Types are separated into two groups -- Accounting Transactions and Update Transactions -- to facilitate the editing process in the daily cycle.

Within each Batch Type there are several transaction type codes. These codes are utilized in the following ways:

1. Reference -- All transactions to be posted to the Financial Data Base have a unique nine digit reference number. The first three digits of this reference number constitute the transaction code which indicates a type of transaction. The last six digits designate a specific transaction in that type. When questions arise concerning a transaction, the transaction code is the key used in locating the original source document.

2. Edit -- All transactions must pass several basic edits. Additional and differing edits are performed on data of certain transaction

types. For example, a Cash Receipt Transaction (types 001-004) must contain a teller number while a Vendor Check Transaction (type 010-014) must contain a valid vendor number.

3. Creation of Automatic Journal Entries -- As batches are processed, the System generates automatic cash equity journal entries and postings to revenue and expenditure control accounts. The type of transaction determines the automatic journal entries to be generated. For example, a Cash Receipt Transaction (types 001-004) requires the creation of a Cash Equity Journal Entry.

D. DAILY MANAGEMENT

Each functional area of the Business and Finance organization prepares batches of transactions and sends them to the Accounting Control Section, accompanied by a batch control ticket (Exhibit IV.5) showing:

1. The type of transactions in the batch
2. The number of transactions, where applicable
3. The total debit amount of the transactions, where applicable
4. The total credit amount of the transactions, where applicable

Personnel of Accounting Control assign a five digit batch control number to each manually prepared batch and record the batch on the Batch Control Log (Exhibit IV.6). The first two digits of the batch control number indicate the month of the year (01-12) to which the transactions apply. The actual batch number within the month is the last three digits of the batch control number. When input is received from another automated system, such as payroll, the batch control number is computer generated.

The Accounting Control Section submits the batches to data processing for keypunching and entry into the daily processing cycle. After the keypunching function has been completed, the batches of source documents are returned to the Accounting Control Section where they are held in a suspense file until such time as they are posted to the data base. The Batch Control Log, augmented by the Data Control Log (Exhibit IV.7), is the key to effective management of the Accounting Information System, viewed from a financial management perspective.

The daily processing cycle is typically executed overnight with the activity and exception reports being the first printed the following morning. This schedule allows the Accounting Control Section maximum time in which to locate and resolve any errors which resulted in the rejection of batches from the previous night's processing cycle.

Each batch is thoroughly edited, and any error within the batch causes the entire batch to be rejected. When an error is detected within a batch of any accounting transactions, the entire batch is routed to the error pending file, and an error report is generated. The Accounting Control Section works with this report each day to prepare correcting entries and thus release the corrected batches for re-entry (Batch type 30) in the next daily cycle. A batch which has an error remains on the error pending file and is reported each day until it is removed or corrected. As batches are processed, the System generates automatic cash equity journal entries and postings to revenue and expenditure control accounts. In this fashion, the System is kept in balance at all times.

The System provides complete audit trails of all transactions. The following activity and exception reports are produced daily:

1. Daily Transaction Control Report - This report lists all the accounting transaction batches which were accepted or rejected for that day, accompanied by debit/credit control totals for each batch.

2. Daily Transaction Error Log - This report is generated for every batch of accounting transactions which were rejected for that day. Each record in the rejected batch is listed with the record(s) in error being flagged by asterisks.

3. Register of Daily Transactions - This report is generated for every batch of accounting transactions which was accepted for that day. Produced in three sequences - account number, transaction number, and automatic journal entry number - this report lists each transaction posted to an account, including any appropriate automatic entries.

E. AUTOMATIC JOURNAL ENTRIES AND BALANCING ROUTINE

As batches of debit/credit transactions are processed and found to be error-free, the System automatically generates cash equity journal entries and postings to the revenue and expenditure control accounts. Thus, debits always equal credits for each batch, major fund group, project, or the entire data base. These automatic entries and their appropriate transaction type codes are:

090	Posting to Revenue Control Accounts
091	Posting to Expenditure Control Accounts
092	Reduction of Vendor Account for Cash Disbursements

093 Recognition of Increase/Decrease in Cash Equity at State Treasurer Expense Clearing Account Level

094 Detail Distribution of Cash Equity at State Treasurer Level

The accounting data base contains all transactions that are entered into the accounting system. Based on Field 2 (Type of Account) in the account number, these transactions can be separated into three ledgers:

1. General Ledger - Field 2 = 50-59, 70-99
2. Revenue Ledger - Field 2 = 01-09
3. Expenditure Ledger - Field 2 = 20-49, 60

The following edits are performed throughout the daily processing cycle to insure that the accounting transaction file is in balance:

1. General Ledger - Field 2 = 50-59, 70-99; the total debits must equal total credits for all transactions in the general ledger accounts.
2. Revenue Ledger - Field 2 = 01-09; the total of all transactions for each major fund group - Field 1 - must equal the revenue control account in the general ledger for the same major fund group.
3. Expenditure Ledger - Field 2 = 20-49, 60; the total of all transactions for each major fund group - Field 1 - must equal the expenditure control account in the general ledger for the same major fund group.

F. OTHER FEATURES

BUDGET MAINTENANCE SUB-SYSTEM

The purpose of this sub-system is to provide a means to record and maintain the budget amounts for revenues, expenditures and transfers for a given fiscal period.

The budget information by account number is used primarily in preparation of the Budget Status Report for Expenditures and Realization of Revenues. A further use of the budget information and budget amendment transactions is to produce, as needed, summaries of budget information across categories of account numbers in order to provide more viable reporting and accounting.

Fiscal year beginning budget information is input at the beginning of the year by way of an original budget entry document. Accounts that are established during a fiscal year have beginning budget data input at the time they are established. Budget amendments are input at any time during the fiscal year in the daily accounting cycle by way of a budget amendment document. A budget maintenance log and error report are provided for all budget transactions.

PROVISIONAL DESIGN FOR GRANTS, CONTRACTS AND OTHER RESTRICTED FUNDS

Special provisions are made for accounts where fiscal periods extend beyond or are other than Clemson University's fiscal year, primarily Grants and Contracts. Project life-to-date budget and accounting changes at the detail level are shown on certain reports until project termination.

Information carried in the data base under these provisions are:

1. Project identification
2. Beginning and ending dates of the grant

3. Original direct and indirect award
4. Revised direct and indirect award
5. Cumulative expenditures for the fiscal and life period
6. Cumulative additions to fund balance
7. Cumulative deductions for overhead recovery
8. Computed revenue to the extent expended by source of revenue

These data elements facilitate the preparation of annual reports for the restricted funds such as Statement of Current Restricted Revenues, Expenditures and Other Changes and the Statement of Changes in the Restricted Current Fund Balance.

The viability of these special provisions also allows for budgeting and report preparation over the life period of the accounts as well as budgeting and reporting restricted to the fiscal year period.

ENCUMBRANCES

Encumbrances are entered from purchase orders or other appropriate documents which may commit budget funds.

Encumbrances are relieved in the daily accounting cycle as postings are made to the accounting data base. Payments are coded either "Full" or "Partial," and are handled as follows:

1. Full Payment

   In this case the encumbrance is relieved in full, irrespective of the amount of the payment as noted in the payment transaction. The encumbrance no longer exists and will be physically removed from the data base.

2. Partial Payment

A partial payment never totally relieves an encumbrance. The encumbered amount is reduced by the amount of the payment transaction. If the encumbered amount becomes less than zero, it is set to zero.

A report is printed of those encumbrances that are zero. These can then be reviewed and modified through the encumbrance maintenance sub-system.

CASH FLOW REPORTS

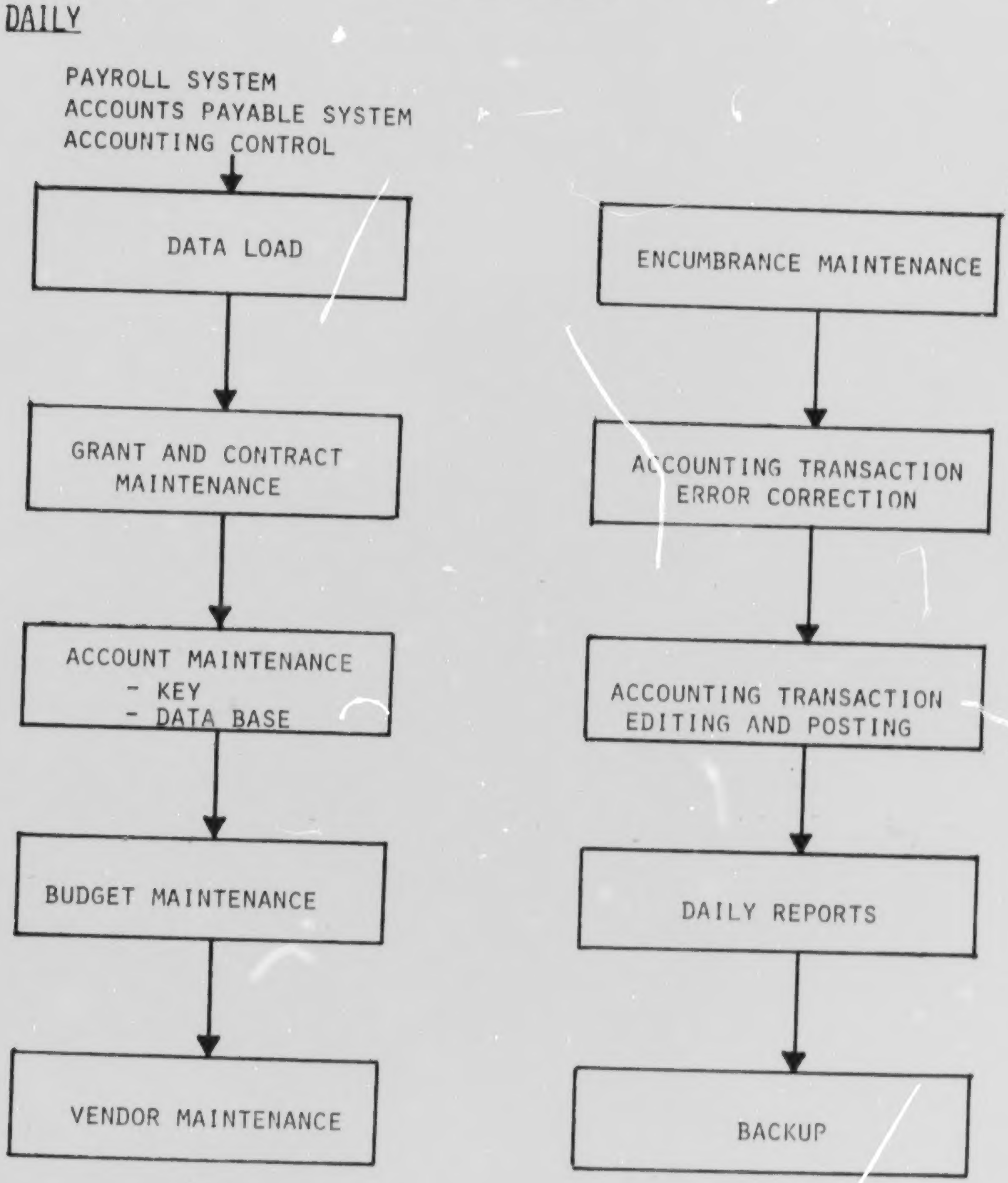
Each major fund group at Clemson University is assigned a corresponding cash account at the State Treasurer's Office. Funds received throughout the month are deposited to a Revenue Clearing Account at that office. A report is produced at least monthly which summarizes by major fund group and, in some instances, funding source within the fund group the automated cash equity journal entries generated for cash receipt batches. This report facilitates the Comptroller's distribution of the balance in the Revenue Clearing Account to the appropriate cash accounts of each fund group.

All disbursements are made from a Vendor or Payroll Bank Account. These accounts are replenished for those disbursements from funds held in an Expenditure Clearing Account at the State Treasurer's Office. This account is established at an approved level at the beginning of each fiscal year. Monthly, the Expenditure Clearing Account is reimbursed for the funds which were deposited in the Vendor or Payroll Bank Accounts.

As disbursements are made throughout the month, no attempt is made to determine the source of funds to be charged for such disbursements. At the end of the month, however, a report is produced which summarizes by major fund group and, in some instances, funding source within the fund group the automated cash equity journal entries generated for all batch types other than cash receipt batches. This report facilitates the Comptroller's replenishment of the Expenditure Clearing Account from the appropriate cash accounts of each fund group.

EXHIBIT III.1

DAILY RUN CYCLE


DAILY
PAYROLL SYSTEM
ACCOUNTS PAYABLE SYSTEM
ACCOUNTING CONTROL
DATA LOAD
GRANT AND CONTRACT MAINTENANCE
ACCOUNT MAINTENANCE
- KEY
- DATA BASE
BUDGET MAINTENANCE
VENDOR MAINTENANCE
ENCUMBRANCE MAINTENANCE
ACCOUNTING TRANSACTION ERROR CORRECTION
ACCOUNTING TRANSACTION EDITING AND POSTING
DAILY REPORTS
BACKUP

AIS DATA BASE

EXHIBIT 111.2

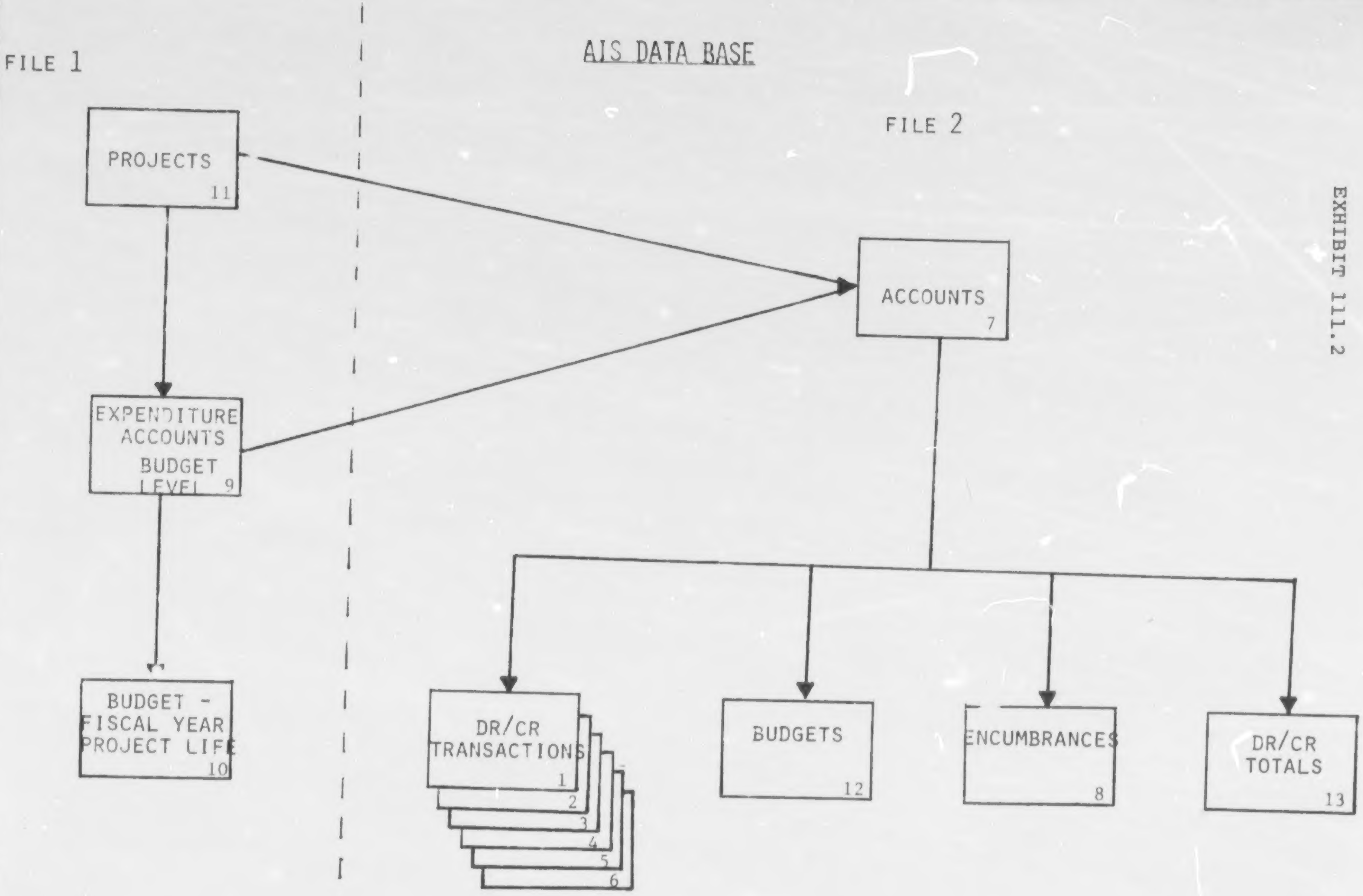

FILE 1
FILE 2
PROJECTS
11
EXPENDITURE ACCOUNTS BUDGET LEVEL
9
BUDGET - FISCAL YEAR PROJECT LIFE
10
ACCOUNTS
7
DR/CR TRANSACTIONS
1
2
3
4
5
6
BUDGETS
12
ENCUMBRANCES
8
DR/CR TOTALS
13

EXHIBIT IV.1

ACCOUNT NUMBER STRUCTURE

FIELD	1	2	3	4	5	6
SIZE & FORMAT	X	XX	XXXX	XXXX	XX	XXXX

FIELD NUMBER	
1	MAJOR FUND GROUP
2	TYPE OF ACCOUNT
3A	OBJECT CLASSIFICATION OF EXPENDITURE
3B	DETAIL SOURCE OF REVENUE
3C	ASSET IDENTIFICATION
3D	LIABILITY IDENTIFICATION
3E	ADDITION IDENTIFICATION
3F	DEDUCTION IDENTIFICATION
4	UNIT NUMBER
5	FUNDING SOURCE
6	PROJECT IDENTIFICATION

CLEMSON UNIVERSITY
TYPES OF ACCOUNTS

0X REVENUES 0X-IX

01 REVENUES - TUITION AND FEES
02 REVENUES - GOVERNMENTAL APPROPRIATIONS
03 REVENUES - GOVERNMENTAL GRANTS & CONTRACTS
04 REVENUES - PRIVATE GIFTS, GRANTS & CONTRACTS
05 REVENUES - ENDOWMENT INCOME
06 REVENUES - SALES & SERVICES OF EDUCATIONAL ACTIVITIES
07 REVENUES - SALES & SERVICES OF AUXILIARY ENTERPRISES
09 REVENUES - OTHER

2X EXPENDITURES AND TRANSFERS 2X-7X
EDUCATIONAL AND GENERAL 2X-5X

20 INSTRUCTION
30 RESEARCH
31 RESEARCH - AGRICULTURAL EXPERIMENT STATION
35 EXTENSION & PUBLIC SERVICE
36 EXTENSION & PUBLIC SERVICE - COOPERATIVE AGRICULTURAL EXTENSION SERVICE
37 EXTENSION & PUBLIC SERVICE - REGULATORY SERVICE
40 ACADEMIC SUPPORT
42 STUDENT SERVICES
44 INSTITUTIONAL SUPPORT
46 OPERATION AND MAINTENANCE OF PLANT
48 SCHOLARSHIPS AND FELLOWSHIPS
53 MANDATORY TRANSFERS FOR LOAN FUND MATCHING
54 NONMANDATORY TRANSFERS

EXHIBIT IV.2-2

AUXILIARY ENTERPRISES 6X-7X
- 60 AUXILIARY ENTERPRISE EXPENDITURES
- 71 MANDATORY TRANSFERS FOR PRINCIPAL & INTEREST
- 72 MANDATORY TRANSFERS FOR RENEWALS & REPLACEMENTS
- 76 NONMANDATORY TRANSFERS

8X OPERATING ACCOUNTS
- 80 REVENUE CONTROL
- 82 EXPENDITURE CONTROL
- 84 ADDITIONS TO FUND BALANCE
- 86 DEDUCTIONS FROM FUND BALANCE

9X BALANCE SHEET ACCOUNTS
- 90 ASSETS
- 91 LIABILITIES
- 92 FUND BALANCES - UNALLOCATED
- 93 FUND BALANCES - ALLOCATED
- 94 FUND BALANCES - RESTRICTED

EXHIBIT IV.3

ORGANIZATION OF ACCOUNTING CONTROL

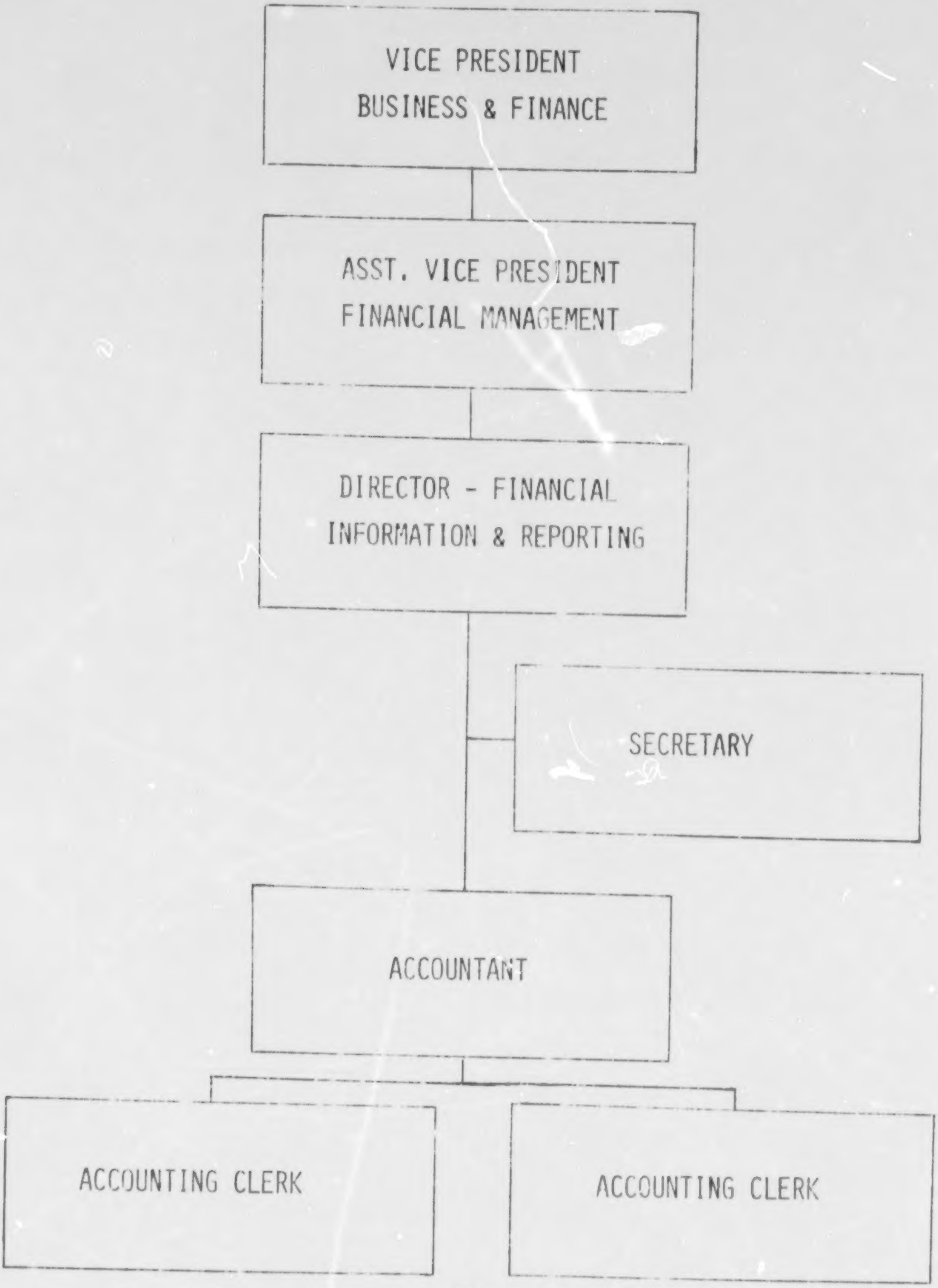

VICE PRESIDENT
BUSINESS & FINANCE
ASST. VICE PRESIDENT
FINANCIAL MANAGEMENT
DIRECTOR - FINANCIAL
INFORMATION & REPORTING
SECRETARY
ACCOUNTANT
ACCOUNTING CLERK
ACCOUNTING CLERK

EXHIBIT IV.4-1

CLEMSON UNIVERSITY
ACCOUNTING TRANSACTION CODES

BATCH TYPE	TRANSACTION TYPE	TRANSACTION DESCRIPTION
02 - CASH RECEIPTS	001	STUDENT PAYMENTS
	002	MISCELLANEOUS RECEIPT
	003	RENT RECEIPT
	004	STUDENT BANK
04 - VENDOR CHECKS	010	VENDOR CHECKS-DIRECT VOUCHERS INCLUDING LIBRARY PURCHASE ORDERS
	011	VENDOR CHECKS-PURCHASE ORDERS
	012	VENDOR CHECKS-HANDWRITTEN-DIRECT VOUCHERS
	013	VENDOR CHECKS-HANDWRITTEN-PURCHASE ORDERS
	014	VENDOR CHECKS-VOIDED
06 - PAYROLL CHECKS	020	PAYROLL (BIWEEKLY)
	021	PAYROLL (HANDWRITTEN)
	022	PAYROLL (VOIDED CHECKS)
	023	PAYROLL (CLOSEOUT CHECKS)
	025	PAYROLL (ACCRUALS
10 - IDT's	035	IDT DISBURSEMENTS
	036	IDT RECEIPTS

EXHIBIT IV.4-2

BATCH TYPE	TRANSACTION TYPE	TRANSACTION DESCRIPTION
12 - JOURNAL VOUCHERS		
	040	TRIP REQUEST
	041	MOTOR POOL MAINTENANCE
	042	CENTRAL STROES
	043	CENTRAL PHOTO
	044	UTILITIES
	045	FRINGE BENEFITS
	046	INSURANCE
	047	CENTRAL MAILROOM
	048	WORK FOR DEPARTMENTS (WORK ORDERS)
	049	WORK FOR DEPARTMENTS (ROUTINE MAINTENANCE)
	050	INDIRECT COSTS
	051	CENTRAL SERVICES
	052	TELEPHONE SERVICES
	053	BOOKSTORE PURCHASES
14 - JOURNAL ENTRIES (CORRECTIONS TO ACCOUNT NO.)		
	060	RECEIPTS CORRECTIONS
	061	PAYROLL CORRECTIONS
	062	VENDOR CORRECTIONS
	063	REFUND CHECKS & CORRECTIONS
	064	IDT DISBURSEMENT CORRECTIONS
	065	IDT RECEIPT CORRECTIONS
	066	JOURNAL VOUCHER CORRECTIONS
	067	MISCELLANEOUS JOURNAL ENTRIES

EXHIBIT IV.4-3

Batch Type	Transaction Type	Transaction Description
16 - Warrant Receipts		
	079	Warrant Receipts
18 - Journal Entries (Other than Corrections)		
	080	Closing Entries
	081	Interfund Entries
	083	Reversing & Adjusting Entries
	084	Payroll Clearing Deposits
	089	Miscellaneous Journal Entries

Clemson University
Update Transactions

Batch Type	Transaction Type	Transaction Description
30 Accounting Transaction Re-entry		
	101	Delete Entire Batch
	102	Add Transaction to a Batch
	103	Change Transaction Data
	104	Delete a Transaction
40 Account Key Changes	201	Add Key Entry
	202	Change Key Entry
	203	Delete Key Entry
42 Account Number Changes	251	Add Single Detail Account Number
	252	Explode on Field 3
	255	Change Detail Data
	256	Add Single Budget Account Number
44 Budget Amendments	301	Fiscal Year Beginning Budget-Expenditure Accounts
	302	Project Life Beginning Budget Expenditure Accounts
	303	Fiscal Year Budget Amendment Expenditure Accounts
	304	Project Life Budget Amendment Expenditure Accounts

EXHIBIT IV.4-5

BATCH TYPE	TRANSACTION TYPE	TRANSACTION DESCRIPTION
44 - BUDGET AMENDMENTS (CONTINUED)		
	305	FISCAL YEAR BEGINNING BUDGET REVENUE & TRANSFER ACCOUNTS
	306	FISCAL YEAR BUDGET AMENDMENT REVENUE & TRANSFER ACCOUNTS
46 PROJECT AWARD INFORMATION		
	401	ADD EXTERNAL PROJECT
	402	CHANGE EXTERNAL PROJECT
	403	CHANGE INTERNAL PROJECT
	404	DELETE PROJECT
48 VENDOR MASTER INFORMATION		
50 ENCUMBRANCE CHANGES		
	601	ADD ENCUMBRANCE
	602	CHANGE ENCUMBRANCE
	603	DELETE ENCUMBRANCE

EXHIBIT IV.6

BATCH CONTROL LOG

MONTH: NOVEMBER

BATCH NUMBER	BATCH TYPE	DATE RECEIVED	DATE SENT TO ADP	DATE RETURNED BY ADP	POSTING DATE
11216	42	11/24	11/24	11/24	11/24
11217	06	11/24	11/24	11/24	11/29
11218	42	11/29	11/29	11/29	11/29
11219	12	11/29	11/29	11/30	
11220	14	11/30	11/30	11/30	

EXHIBIT IV.7

DATA CONTROL LOG

MONTH: NOVEMBER

TYPE OF DATA	NUMBER OF BATCHES EXPECTED	NUMBER OF BATCHES RECEIVED	NUMBER OF BATCHES ENTERED IN AIS
CASH RECEIPTS			
VENDOR CHECKS (REGULAR)			
VENDOR CHECKS (VOIDED)			
VENDOR CHECKS (MEMO)			
PAYROLL CHECKS (VOIDED)			
PAYROLL CHECKS (HANDWRITTEN)			
IDT			
JOURNAL VOUCHERS			
JOURNAL ENTRIES (CORRECTIONS)			
WARRANT RECEIPTS			
JOURNAL ENTRIES (OTHER THAN CORRECTIONS)			

DATA SYSTEMS AND ANALYSES: DECISION MAKING FROM DEMAND TERMINALS

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This paper is directed toward administrators facing the challenge of meeting ever increasing demands for data with a constant level of resource support. The approach discussed, creation and utilization of special student and faculty data files from existing operational data systems, accessed via an on-site demand terminal, is one both practical to implement in terms of the costs involved, and one likely to result in significant advances in data-based decision making. This paper includes detailed specifications of one such system currently in use, illustrative output, and descriptions of the volume of analyses made possible through its use.

DATA SYSTEMS AND ANALYSES: DECISION MAKING FROM DEMAND TERMINALS

If one peruses the literature on decision-making, it becomes apparent that many differing theories are being expounded. One aspect that each of them have in common, however, is the involvement of choice. The continuum of this theoretical discussion of choice extends from a definition of decision making as an elimination of choices to decision making as an accumulation of choices, with many complex variations of these two extremes in between. There are, however, statements we can make about decision making or the decision making process which apply within most theoretical frameworks:

1) decision making is very personal
2) decision making is never totally objective
3) decision making is rarely democratic
4) a decision is usually not made in isolation
5) decision making is not a spectator's sport
6) decision making is often times an unconscious process
7) decision making is frequently lonely

Regardless of the theory utilized, each implies that decision making is the resolution of conflict of one kind or another, whether between people-to-people issues, places-to-people, things-to-people, things-to-things, etc. It is therefore simply some area of disagreement between one or more parties, places or things.

There are at least, four broad sources of potential conflict in the working relationships of individuals which can interfere with the decision making process. These conditions which can lead to conflict include: differences in organizational role, differences in status, communication breakdowns resulting from the use of specialized language or jargon and the absence of synchronization between decision makers and the providers of the information for decision making and the definition of problems in the identification of solutions.

How can these sources of conflict be reduced and the decision making process enhanced? What associated factors can be identified which will alow individuals to proceed through the decision making process with the least outside distraction? Some of the measures suitable for the reduction of conflict include:

1) linkage - This refers to the degree to which individuals can establish satisfactory interpersonal contact.
2) structure - The division of labor should be established in a clear and acceptable way. It is important that individuals understand whose responsibility it is to do what and who makes the final decision in what areas.
3) openness - This is the readiness to give and receive which people must be willing and able to deal with.
4) capacity - The need to expand one's ability to deal with large volumes of information efficiently.
5) reward - The extent to which a person is positively reinforced.

6) proximity - The degree to which individuals have easy access to one another.

7) persistence - The desire to promote consistency in the communication of ideas, problems, solutions, etc.

When dealing with the design establishment and use of complex data systems we almost always design these systems to accommodate operational processes and only incidentally or as a by-product consider the informational needs required by decision makers. Yet we can never expect the decision making process to maximize itself if data systems do not exist which can respond efficiently, effectively and in a timely manner to the needs of those in the decision making process. Therefore it is important for each institution or organization to decide what combination of factors are required to maximize the decision making process, what data base is needed to support that process, and what role data systems management will have in the act of deciding.

We were determined at Florida International University to evolve a man/woman/machine interface which would utilize the technologies available to the fullest so as to enable the decision makers to have data available when it was needed. We were convinced that most operational files, in not being originally designed for administrative decision making, were in need of modification.

In order to accomplish the aims elaborated above, the Office of Institutional Research created a special file, known as OPAFLOW-FILE (referred to as the flowfile). containing demographic, and term-by-term information for every student who ever attended the University. The term-by-term information consists of entries such as hours, major and level and is available by term only on the flowfile. The STUDENT MASTER, the other major file accessed by the O.I.R. is used to update the flowfile for each quarter. The STUDENT MASTER contains many more pieces of information on each student than does the flowfile.

The F.I.U. Computing Center wrote a special linkage program making it possible to analyze all data on the flowfile and the student master using an extensive series of canned statistical programs (called STATJOB) available from the University of Wisconsin. Thus, with statjob and the files as described above, an almost infinite variety of analyses became feasible and it became possible to respond to a wide range of questions from University decision makers.

The following are selected excerpts from a manual prepared to aid in the use of the demand terminal and the special institutional research files.

Questions:	When should the flowfile be used rather than the student master?
Answer:	Since the flowfile is the only source of term-by-term information, whenever an analysis requires examination of more than one term at a time, it is the file to be used.

For example, to obtain the number of students who enrolled Fall '72 *and* Fall '73 *and* Fall '74, the flowfile would be scanned for students current (designated by "c") Fall '72 ("c" in column 77), current Fall '73 ("c" in column 149 and current Fall '74 ("c" in column 221).

In general, any analysis requiring data from a term other than the current term should be handled via the flowfile.

Question: How does one apply a statjob procedure to the flowfile?

Answer: Initially it is necessary to become familiar with basic statjob procedures which are described in the documentation available from the University of Wisconsin, and with the University of Maryland text editor which is the tool used for file creation and modification. Essentially, the steps to the programs require:

1. Identification of the program to be used:
    a. *Crosstabulations* - This is the program most frequently used and since it provides basic frequency data and it enables one to view the extent of the relationship existing between two or more variables.
    b. *Trans 1* - This enables any elements of the file to be converted in any manner to either create a new file, output it in its new form or analyze it.
    c. *PICT 1* - These allow for the creation of graphs and/or tables to illustrate relationships.

d. Oneway 1 (etc) - This is the basic analysis of variance procedure which enables one to determine whether significant differences exist between two or more groups on a continuously measured variable.

2. Location of the data elements of interest (using "F" and "A" formats).

3. Determination of row, column and control variables (where necessary) if crosstabulations are desired or of other variables where any of the other analyses are to be performed.

For example, if one desired to know the number of Black males and females in attendance for the Winter Quarter 1976, the following information would be involved:

1. The program to use is crosstabs.
2. The variables involved are "current" for Winter Quarter 1976, race and sex.
3. The location of the variables are as follows:

		Column		Field Width
Current Winter 1976	=	311	=	1 field
Race	=	11	=	1 field
Sex	=	10	=	1 field

4. The row variable could be race, the column variable sex and the third classification, known as control, is current. The table will print out as follows:

Row. . . . . .race

Column . . . . .sex

Control . . . . .Current

		1	sex 2	total
Race	1			
	2			
	3			
	4			
	5			
	6			

Note that for race, the numbers 1 through 6 correspond to Black, Asian, Indian, Hispanic, White and other and the requestor has the choice of having a label or the number printed out. The same applies for sex and, instead, for any other variable it is possible to display the actual value it takes (in the file) or any other label one wishes to apply.

Question:	What kind of analyses has the Office of Institutional Research already performed and are they available for new applications?
Answer:	The Office has performed hundreds of analyses using the flowfile and the student master since the linkage program was written. Most of these programs are available in our own file, stored on disk, (referred to as FILENAME in this request) through any of the demand terminals located on Campus.

Example of Runs	Location on IPAECL
1. Crosstabulation using as the row variable the student's institution of last attendance and the quarter in which he first registered as the column variable. The number in each cell therefore represents the number attending F.I.U. from a particular school for a particular job.	FILENAME. STATJOB-10 The following statement on the terminal will retrieve the program: @ run .... @ ED FILENAME. STATJOB-10

THUS TO OBTAIN AN ANALYSIS OF INSTITUTION OF LAST ATTENDANCE BY QUARTER FIRST REGISTERED, BEGIN BY ASSESSING STATJOB-10 AND MAKE CHANGES AS NECESSARY.

2. Crosstabulation of the degrees earned by major for every quarter.	FILENAME. PROFILE-10

THUS FOR UP-TO-DATE GRADUATION STATISTICS, BEGIN BY ACCESSING PROFILE -10/

For analysis of degrees earned by sex By program see	Profile - 06 Profile - 07 Profile - 08
3. Crosstabulation of numbers of new students by first quarter registered	FILENAME. STATJOB-13

Example of Runs	Location on IPAECL
4. Crosstabulation of major in one quarter by major in future quarters (Changes in major).	FILENAME. FLOWJOB -13
5. Attempt to discover total hours needed to graduation by transformation of total hours earned with current hours with hours transferred in.	FILENAME. PROFILE -01
6. Enrollment for current quarter by major, race, sex, etc.	FILENAME. SELECT -02 through SELECT - 08
7. Line graphs and tables for Headcount for all quarters for FTE for all quarters	FILENAME. GRAPH -21; 22 FILENAME. GRAPH -31; 32
8. Fortran Program which accesses a TRANS 1 "pick" off Transcript file in order to compute G.P.A. for veterans.	FILENAME. CLARK - 2 FILENAME. KARIM - 50
9. Transformation to convert year of birth to student age.	FILENAME. KARIM - 15
10. Random sample check using last digit of social security number.	FILENAME-RANDOM - 01

Question: How may interested users avail themselves of the many available programs?

Answer: Since most programs are stored on disc they are available for modification according to individual needs and, therefore, it is not necessary to construct them over entirely for each new situation. For example, to do a crosstab on the flowfile, begin by accessing one already done and stored on FILENAME; FLOWJOB-11. Look at this program on the scope, as follows:

```
@ED FILENAME.  FLOWJOB-11
```

P (for print) * (the entire program)

(This is the language of the University of Maryland Text Editor, which is used to modify existing file elements and to create new ones).

Looking at Flowjob-11, you will note it deals with the variables level and major. To modify it, you must first copy Flowjob-11 into another element so that Flowjob-11 is still available in its original form; as follows:

```
@ ED FILENAME.  FLOWJOB-11, FILENAME.  NEWJOB-1
```

FILENAME. NEWJOB-1 is now a duplicate of Flowjob-11 and available for your use while the original Flowjob-11 is of course, unchanged and available in its original form for other users.

Referencing the documentation of the flowfile will enable you to determine the location of the variables of interest to you. Use this to alter all statements of NEWJOB-1 which need changing. When you ahve completed your editing, the command

@START FILENAME. NEWJOB-1 will initiate the run.

Obviously, NEWJOB-1 is now available to you for future editing.

Question: May files, other than the flowfile and student master be utilized in the manner described above.

Answer: All University files can be accessed for STATJOB processing though some may require preparatory type runs (through a STATJOB procedure) prior to running the desired analysis. The Office of Institutional Research has, to date, utilized statjob with the following additional files:

Academic Assignment File
Transcript File
Catalog File
Student Fee System File
Course Schedule Master File
Course Master File

For examples of how these files have been utilized, see:

Academic Assignment File:	FILENAME. SELECT-14 (Analysis by rank & salary of faculty)
Transcript File:	FILENAME. SELECT-62 (Analysis of credit hours by department by quarter as part of I.E.P. study)
Student Fee System File:	FILENAME. STATJOB-5 (Analysis of student fee balance according to total fee assessed)

The O.I.R. is convinced that this approach to data analysis makes it possible to be responsive to a much greater number of requests than would otherwise be possible and to do so with a more acceptable degree of accuracy and within tighter time constraints. The fact of the matter is that autonomy, coupled with ease of access leads to more efficiency than is ever available when the locus of control is elsewhere.

The location of a demand terminal in the O.I.R. has made it possible to supply analyses when they were needed and to do so in an effective and efficient manner. In so doing, the Office has been able to become involved in the mainstream of policy-making and to provide meaningful assistance to the University in its quest for data-based decision-making.

GAINING INSTITUTIONAL INVOLVEMENT IN THE SYSTEMS DEVELOPMENT PROCESS

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All services oriented data processing organizations involve their users in the design and implementation of information systems. As the systems evolve towards a shared data base environment, however, the coordination across organizational boundaries often becomes more complex. For the past three years, the development of administrative data processing systems at Penn State have been the responsibility of a central advisory group comprised of institutional officers. A central fund is used to support the feasibility study, systems design, development, and systems implementation. The operations costs are borne by the administrative user as are subsequent systems enhancements (modification).

The advisory group evaluates and ranks proposals for selection. Priority projects are staffed with user representatives from the appropriate sectors of the University as well as systems analysts. All development efforts are conducted in a series of phases; the first phase (Systems Study and Evaluation) is reviewed by the advisory group which make a go no-go decision. If approved, subsequent phase reviews are conducted by a designated committee member(s) who represents the user(s) of the system.

Some of the advantages gained by this central focus towards systems development include the following:

1. Precoordination is achieved for systems which cut across organizational boundaries (e.g., Colleges supply data which are processed by Payroll and are used by the Offices of Affirmative Action and Personnel).
2. Opportunities exist to adjust the scope of a system to encompass more information problems than may be perceived by the proposal originator.
3. Return on Investment evaluation is performed at a level where costs and benefits can be weighed relative to a wide range of problems and opportunities for the institution.
4. Judgement concerning systems priorities are debated among the community of users; alleviating (somewhat) the pressure on the Data Processing organization to satisfy each user's demand for scarce personnel resources.
5. Project proposals and reviews provide an excellent forum to exchange information and viewpoints between the DP organization and the using community.

Furthermore, this central focus towards systems will be critical to the requirements for administering an integrated data base shared among a community of users.

This paper describes the communications and decision process for allocating the System Development resources. It also describes the methodology used to balance the personnel demand between systems development (a central responsibility) and systems modification (a user responsibility).

A SALARY SOLVENCY MODEL: UPDATE

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A paper was presented at the 1975 CAUSE National Conference on the Salary Solvency Model. This "Update" presents an actual case history pertaining to the application of the model. In addition, a status report is given with respect to technical improvements to the computer program, particularly regarding an exact solution versus a Monte Carlo simulation.

MANAGEMENT AND CONTROL OF SYSTEMS ENHANCEMENTS

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Florida State Board of Regents
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This paper provides an insight into the organization and management of the systems enhancement function. It outlines personnel resource requirements, procedure development and operational methods. The information in this paper was compiled during the establishment of an enhancement unit serving nine State university users of a uniform transaction accounting system. It is adaptable to any size maintenance unit and may be used over a wide range of computer applications. This paper stresses the need for the enhancement team to be a separate unit of highly skilled technicians.

Administrative Systems in Administrator's Hands

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The Systems Development Department at Virginia Tech has been developing and implementing administrative systems since 1969. The emphasis has been to produce a system upon request and then have the user office accept the responsibility for its operation, and in some cases, its maintenance.

This paper examines the approach of administrators owning their systems at Virginia Tech with emphasis on operational systems such as Accounting, Student Records, Telephone Billing, Library, and Alumni. It examines the various steps taken thus far by administrative offices to exercise control over their own data processing system, and their interaction with the overall university management information system, Systems Development, and the University Computing Center.

ACQUIRING A COMPUTER: 10^6 EASY STEPS

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This paper discusses need assessment procedures, constituent involvement, RFP organization, vendor relations, evaluation techniques, bench marking, legal complications, and both academic and administrative needs for a multi-campus community college.

INFORMATION SYSTEMS FOR PLANNING - PANACEA OR TOOL

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The use of computerized information systems for educational planning has increased dramatically in the past few years. This is the result of educational institution operations becoming more sophisticated and complex in response to demands for better fiscal accountability, improved resource allocation, and mandated public access and disclosures. However, the value of the higher education enterprise product is not so easily quantifiable, as is the value of an item from a production process. Faith, judgment, and value are at the core of the educational process and not production rates, material costs or inventory control.

The peculiar nature of the educational enterprise strongly suggests that information systems for educational planning are best used as tools. Total acceptance of information systems will result in time and resources being wasted in those areas where benefit/cost ratios are marginal or where administrators view reports in a lethargic manner. The primary responsibility should be on the information system user to request reports in those areas where the need for the data outweighs the capability of being able to collect the data. The measure of success of an information system is the use of the system reports and not the completed system implementation.

Certain areas of university operations are not prime candidates for the use of information systems, because the "products" of universities are educated people and knowledge, which are not so easily measured. However, information systems do have a significant role in universities, and we should not capitulate in our efforts to assure that justifiable systems contribute to their maximum potential.

MARSHALL MCLUHAN'S REAR-VIEW MIRROR: INFORMATION SYSTEMS AND INNOVATION

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McLuhan, Mead, Lock Land, Toffler, Fuller and Drucker all suggest that many administrators drive our institutions into the future with their eyes fixed on the rear-view mirror. This criticism is particularly pertinent to higher education where even though decision-makers are increasingly inundated with information, our decisions are often more uninformed than ever. As a consequence, much "innovation" is an illusion. A basic problem in planning is our absence of vision, our failure of imagination, which results in seeing the future only as a form and function of the past. Using ideas from the social analysts listed above, metaphors from several children's stories (e.g., "The Emperor's New Clothes," "A Christmas Carol"), and statements by experienced administrators, we will seek a synergetic symbiosis of RRPM 1.6 and imaginative vision which will enable us to face the future openly. Only when we reconcile the dualisms of past and present, quantity and quality, efficiency and effectiveness, verification and value-laden vision, can information become energy; and only then can information stimulate (not simulate) transformation and innovation.

ON-LINE REGISTRATION SYSTEM

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The paper presented at the CAUSE Seminar dealt with the design of an On-line Registration System. The entire system concept was described by means of the flow of information that results as a student preceeds thru the entire registration process. It begins with the admission of a student application and describes in sequence what functions occur and how the system handled the flow of data in the registration process.

An IBM System 370/125 computer with 256 memory using DOS/VS and employing CICS/VS is used. Information is entered via IBM 3270 video terminals located in the Registrar's Office.

The system uses its own data base and integrates the master schedule file, student master file, student schedule file and student payment file. The basic system concept is built on a transaction driven function, using video displays, that prompt the terminal operator. Ease of operation is a significant factor in system design and an operator can be trained in several hours. Programs are written basically in assembler language using CICS/VS as the communication language.

The paper stresses the main attributes of the system as to the importance of bringing student and computer process toegether in performing an On-line Registration function. The importance of conflict identification, ease of changing master schedules and quick identification of problems are prime attributes of the system.

From the faculty standpoint, the grinding burden of registration has been removed and their time can now be channeled to their many instructional duties. They have been unanimous in their praise and in their support of the system. Instead of working one to two weeks full time each registration period, often involving day and evening, they are only required to counsel students during regular conseling hours.

From the student viewpoint, he no longer needs to make more than one visit unless he decides to drop and add classes. Also, he knows immediately if he has the schedule he has requested, including the exact fees which must be paid. In case of a conflict in his schedule, he can solve it immediately, and often this entire process can be accomplished between classes. For the student who can't seem to make up his mind, he can have as many changes as he desires.

In general, it has made the registration process much simpler, easier, and faster for the student; hence, because of these benefits, they have been very favorable toward the system.

From the administration standpoint it has provided many direct as well as indirect benefits. One of the main benefits is that the volume of the drop-and-add processing has decreased substantially since the student is able to get what he desired. The drop and add has decreased nearly 80 percent.

Another benefit is in the time required to process registration. No overtime expense has occurred for the registration process since the system has been installed. In the past entire weekends were spent by many departments to process the volume of work.

The students and faculty can be sure that the class lists and student schedules are accurate. This was not so during the manual registration processes. The accuracy of the process has been extremely effective in determining FTE for state reporting.

Administratively the system has provided better control of class loads, calculation of fees and collection of fees, as well as better control of student obligations, graduation requirements, co-requisites, lab requirements, etc.

With the use of off-campus terminals, remote registrations have been effectively tied into the system and has simplified the registration process. Now a student can register for any class on any campus and pay his fees at the site in which he registers.

Since all data is entered on-line and validated immediately, the collection and reporting of information has been greatly simplified as well as being more accurate. More information can be collected in a shorter period of time notably changes in student addresses, career goals and financial recording of fee changes.

Finally, the system provides better methods for control and accounting of student loans, scholarships, etc. which is essential to our auditing procedures.

The Ideal Generalized Data Management System --

The UWSP Model

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The subject of the paper is the ideal Generalized Data Management System (GDMS) as conceived by a special project team at the University of Wisconsin-Stevens Point (UWSP); an evaluation of several current offerings with respect to the UWSP Model; some predictions of what remains to be developed before we have a real GDMS; and some suggestions on how the user community can hasten its delivery. The emphasis will be on the development and use of a comprehensive model that speaks to generalized data entry and retrieval as well as generalized data base management.

Generalized data management systems (GDMS) are addressed at the conceptual level. The model provides a basis for specifying what facilities a generalized data base management system (GDBMS) should provide and how a GDBMS should interface to the user. A similar approach to our data entry and data retrieval needs resulted in the identification of an integrated list of facilities and capabilities to support the ideal. This list of features includes provisions for:

1. A common data element dictionary to satisfy all data element definitions for all processing.

2. A common forms dictionary to satisfy all logical file/record definitions for all processing.

3. A common "values" dictionary to satisfy all data editing and conversion requirements.

HOW TO WIN THE M.I.S. MAINTENANCE BATTLE

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Several years ago Data Systems and Services at Indiana University underwent a structural reorganization to separate the systems development function from the systems maintenance function. The following two groups were established: The Systems Development Group which was assigned the functions of designing, programming, and implementing new M. I. S. systems and the Systems Assurance Group which was assigned the functions of emergency and planned maintenance.

The organizational separation of the systems development and systems maintenance functions necessitated the creation of new techniques and procedures to enable Systems Assurance to learn, maintain, and control the M. I. S. systems being implemented by Systems Development. These techniques and procedures included:

1. an opportunity for Systems Assurance to learn the M. I. S. systems while they are being developed;
2. an interface between Systems Development and Systems Assurance to insure that the new systems are properly documented and implemented;
3. a committee consisting of the major data processing users at the university to review all enhancements and essential maintenance to the systems once they are implemented; and
4. a form and workflow procedure to coordinate and control maintenance requests from both Operations and the user.

DEVELOPING A FACILITIES DATA BASE FOR THE UNIVERSITY OF TENNESSEE

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The University of Tennessee adopted an overall MIS development plan in July 1974. This plan called for developing each of the five NCHEMS recommended data areas in a three-step process. The first step is to develop a data base structure into which data may be loaded and from which reports may be generated. The second step is to develop a way the data may be kept updated in the data base without reloading all of the data each time. The third step is the conversion of existing operational systems to interact directly with the data base.

Since this was a new approach for developing computer systems for the University of Tennessee, it was decided that the Facilities Data Base should be developed first as a pilot project. The main reason for having a pilot project was education. It was necessary to educate the people involved in the development of a data base as well as the users of the system. There were many reasons for selecting Facilities as the data area to use for the pilot project. Size and availability of existing data were two important ones.

This pilot project has been completed. A pictorial representation of the data base structure and security access method are given in this paper in Figures 1 and 2 respectively. Also some of the things that were learned about developing data bases and Management Information Systems are presented.

DESIGN AND IMPLEMENTATION OF AN ON-LINE DATA BASE SYSTEM

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This paper will cover the design and implementation of an on-line data base system for educational fund-raising, using IMS-VS. The system was designed for the University of Illinois Foundation, the fund-raising arm of the University of Illinois, to meet the following objectives:

1. Provision of needed data for management decision-making.
2. Ease of use by development personnel.
3. Support of selective fund-raising campaigns.
4. Utilization of new software and hardware technology.

This system services all three campuses of the University of Illinois and maintains data on 80,000 donors. Over 20,000 gifts are processed annually with data entry made on all three campuses, and processing performed by an IBM 370/168.

The data base is structured around information "segments." Any one record may have one or more segments associated with it, thus providing maximum efficiency and flexibility in the storage and retrieval of data. Other unique features of the system and the operating environment will be discussed.

Library Circulation and Finding System at Virginia Polytechnic Institute and State University

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The Virginia Tech library circulation and finding system is developed on a HP-3000 minicomputer. This paper gives a brief overview of the functional areas of the system. One of the primary objectives of the system is to provide a quick and efficient method for the check-in and check-out process. Bar code and light pen technology are used to facilitate this process. The system, however, is much more than a circulation system. It has several searching and finding capabilities built in. The searching is hierarchic in nature in that starting at any higher level, it is possible to retrieve at lower levels without rekeying any information. Data may be searched using item number, call number, author or author-title-date key. Two formats are available for data entry. The short format includes only the minimum data necessary for circulation operations. The long format, used for newly acquired items and items processed during a shelf by shelf conversion, consists of approximately 200 bytes of bibliographic data. The system is complete with data base logging as well as back-up and recovery procedures.

PURCHASING/ACCOUNTS PAYABLE DATA BASE

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This is a hierarchially structured base linked to a budget/accounting base by an encumbrance block.

Input is from Purchasing, Receiving, and Accounts Payable using C.R.T.'s. Purchase order detail is keyed in, using a vendor reference. The Receiving Department entry of units received is by order reference. Accounts Payable, by reference to the order number on the invoice, scans the order, then keys in the invoice units and dollars by line item of the order. Either receiving or invoice data is simply entered by "ALL" when in agreement with the order. Purchasing establishes, for each order, whether receiving data is required and a code reference to measure invoice sums against the order. This varies from exact price to a percent tolerance. When the invoice does not pass the measuring test, then an exception is generated to the buyer.

The daily output of routine runs includes purchase orders for review and signature by the buyer. Each buyer also receives an invoice exception report for review and adjustment on a change screen. Message capability is included to secure a copy of the invoice or other communication needed. Inquiry screen for individual status display of order/invoice data is as needed by any user of the system.

Retrieval of invoice data for checks and registers is by routine payment periods. This includes an automatic journal set for entry into the accounting base. Cash flow and other general status reports are also generated at this time, which reflect performance by buyer and the exception status by vendor.

ADMINISTRATIVE SYSTEMS DEVELOPMENT WITHIN THE CALIFORNIA STATE UNIVERSITY AND COLLEGES (CSUC)

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The CSUC system, consisting of nineteen campuses and a Chancellor's Office, is committed to satisfy expanding administrative data processing needs by sharing resources and talents and by not proliferating effort and costs. Within the Chancellor's Office, the Division of Information Systems has the task of developing administrative systems to meet the needs of the nineteen campuses and the Chancellor's Office. In accomplishing this task a number of problems must be solved: differences between campuses, campus desire for decentralization, changing personnel roles, time lags, multi-vendor computing environment, competing programs, and unreasonable expectations. To achieve the objective, DIS has organized its Administrative Support Group along functional lines. To encourage campus participation, nine positions have been transferred to the campus to work on mutually acceptable systemwide projects.

In addition to other major planning input, four task forces of from six to eight campuses were formed to determine needs and priorities in the areas of personnel, students records, curriculum planning, and business. Current progress to date has resulted in agreements to develop and install a number of systems. Further progress is expected until a completely integrated systems environment is achieved.

THE CONCEPTUAL DESIGN OF THE ILLINOIS BOARD OF HIGHER EDUCATION MANAGEMENT INFORMATION SYSTEM

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This paper presents the Illinois Board of Higher Education's approach to the development of a management information system. This approach was dictated by certain environmental realities; these being, the goals which the information system is intended to achieve, an analysis of the present operations of the Board, and a prediction of the future data processing technology which will drive the system. This paper discusses how these environmental factors affected the conceptual design.

UNDERSTANDING THE INFORMATION NEEDS OF COLLEGE AND UNIVERSITY DECISION MAKERS: CHALLENGES TO SYSTEMS DEVELOPERS

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Recognizing that computerized information systems have an important role to play in meeting the information needs of educational decision makers, system developers are encouraged to become aware of their utility in the context of managerial planning, organizing, controlling, and evaluating. This paper outlines several factors system developers must consider before developing or modifying automated information systems useful to educational managers. For one, system developers should identify the management strengths and shortcomings of information users, e.g., department chairpersons, deans, and executive officers. The paper discusses several reasons why these managers typically lack familiarity with: 1) the wealth of data available to them; 2) the information system development and processing capabilities of their institution; and 3) ways to utilize these resources to aid in academic management. Another factor concerns identifying the differences between operational and managerial uses of information. A third factor focuses on identifying the uses of decision information in the context of management responsibilities. Problems relating to top management involvement in information system development and the implementation of purchased planning and management tools are also discussed.

The paper concludes by recommending that system developers initiate informal discussions with academic managers and their staff who prepare management information. Concern is expressed about the quality of data typically derived from operational reporting systems and system developers are challenged to share this same concern. Finally, system developers are encouraged to carefully determine the applicability and feasibility of implementing purchased planning and management tools before trying to operationalize them.

UNIVERSITY ADMINISTRATIVE STRUCTURE: WHAT SHAPE WILL YOU BE IN?

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The successful assimilation of EDP technology by an organization depends on that organization's readiness for the technology. However, to date, EDP has crept into many of our organizations and its forward thrust is one we have reacted to, not planned for.

Thru an analysis of the evolution of University administrative structure, and the movement of EDP within the structure, we can assess where we are in the progression and perhaps get some ideas on how to plan for what lies ahead for our organization.

For many, EDP begins as a function of the accounting department, under the controller. In that position it grows to the point where it requires its own management and thus becomes an individual department still under the controller but on the same level with accounting where it can begin to perform other than just accounting functions. As more non-financial areas become aware of EDP, autonomy of the department within the structure is required to facilitate organizational access with less involvement of the financial area. Thus EDP moves from the financial arena to a position under the Provost or Vice-President for Administration. This move is usually accompanied by the naming of a Steering Committee under the President whose function it is to assist in the management and direction of the computing service area. Finally, the organization takes the step of naming a Vice-President for MIS who oversees not only the immediate area of computing service, but also the user involvement in the development and use of the service.

These administrative structural changes are the result of organizational growth and movement. As managers, we must familiarize ourselves with the forces which trigger these changes, guide and direct the progression of specialization in data processing personnel, in technology, in user personnel and finally develop the managerial talent required to stay ahead of the growth.

STATE LEVEL HIGHER EDUCATION INFORMATION SYSTEMS IN A LIMITED GROWTH ENVIRONMENT

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During the next decade higher education enrollment in this country is expected to stabilize. However, the environment within which higher education operates will continue to be dynamic. That environment will continue to be influenced by changes in federal policies, state policies, demand for trained manpower, student choice, etc.

At the present time some states are using automated information systems to assist in the governance and coordination of higher education (e.g., New Mexico), while similar agencies in other states have made no use of computer technology (e.g., Kansas). The NCHEMS State Level Information Base project can assist in the development of such automated information systems. Future demands for different types of statewide higher education funding formulas, new types of data elements (e.g., program quality indices), and new requirements of federal agencies such as the National Center for Education Statistics will have a direct impact on the development of state level higher education information systems during the next ten years. As higher education enrollments decline and as financial resources become even more limited, state level higher education information bases will probably become increasingly more important.

ARRANGEMENTS FOR MEETING STATE INFORMATION REQUIREMENTS: INTERMEDIATE FILE STRUCTURES

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The procedure developed in Connecticut was to establish common definitions and computer file formats for a limited number of data elements. Institutions placing data in this format are relieved of compiling data to answer a multitude of state questionnaires. Programs written to compile data for a particular questionnaire can service all participating institutions.

The elements listed in the intermediate files were derived by looking at various questionnaires and listing the data needed for completion. For instance, the student file page gives the various HEGIS report numbers (right column) which use particular data elements. Conversely, the twelve pages for the twelve months list the data element numbers required for each questionnaire. Thus, an institution knows what data will be requested and when it will be requested.

The message conveyed in studying questionnaires throughout the year is that there is a large amount of redundancy in requests. If institutions answer questionnaires by manual completing, the workload will grow with each small addition or change. On the other hand, if institutional responsibility is limited to providing the data and maintain the data as prescribed, state agencies can increase their requests for new arrangements of data (information) without seriously impacting the institutions. Most importantly, the separate breakdowns and arrangements of data needed by various state agencies can be tolerated; various application programs can compile data in various ways without affecting institutions in any way.

THE USEFULNESS OF INFORMATION SYSTEMS IN SUPPORTING CURRICULUM INNOVATIONS:
WPI PLAN EXPERIENCE

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This paper assesses the usefulness of information systems in supporting the implementation of academic program innovations, citing the WPI Plan experience as a case example. It is based upon the experience of a project in which Arthur D. Little, Inc. (ADL) is assisting the staff of Worcester Polytechnic Institute (WPI) of Massachusetts. This project is partially sponsored by a grant from the Exxon Educational Foundation, under its Resource Allocation Management Program. The objective of the project is to design and implement an information system that will assist WPI academicians and administrators in better monitoring student progress under WPI's new academic program — the WPI Plan, a nationally renowned, individual, competency-based approach to undergraduate engineering curriculum.

The development and implementation of the WPI Plan constituted one of the most dramatic changes undertaken by WPI in its entire 110-year history. The Plan stipulated that an academic degree would be awarded on the basis of competencies demonstrated in four degree requirements: (1) A qualifying project dealing with a problem in one's major area of study; (2) A qualifying project relating science and technology to societal concern; (3) A sufficiency or minor in an area of humanities; and (4) A competency examination in a major field of study.

The implementation of this new academic curriculum required potential modifications and restructing of the administrative infrastructure used to support WPI's academic programs.

Implementation of the WPI Plan has placed severe administrative demands on all WPI administrators. Some of the problems faced include more frequent student registrations; multi-disciplinary teaching approaches for most faculty members; and student participation in academically relevant projects—to name just a few. An on-line, computer-supported registration system has been developed which students may use in planning their academic programs for an entire year. During the course of this project, the ADL and WPI staffs have been working collaboratively to develop an information system that will permit academic administrators to monitor student performance under the WPI Plan more effectively. The systems planning process separates the major data processing functions: 1) Systems planning, including a needs assessment and a conceptual design of the information system; 2) Systems development, including detailed design, coding, testing and implementation; and 3) Systems operation. This systems planning process, developed by the ADL staff for our work in the business sector, is being modified to meet the unique needs of educational institutions.

The information system developed at WPI has proven useful from several perspectives (students, faculty and academic administrators) in supporting the implementation of the academic program innovations. The system permits students to plan their individualized programs one or two years in advance, and to gain access to the requested courses and project, given priorities and resources available. Students are also assisted in disseminating information concerning projects in their area of interest. From a faculty member's point of view, more timely and accurate information is available for advising students in the development of an individualized program, and in assisting faculty members in registering students and assessing their progress under the WPI Plan. From the academic administrators point of view, the information system helps monitor the resources necessary to support the learning experiences of the WPI Plan. The currently available components of the WPI Plan focus upon controlling the resources available for achieving the objectives of the WPI Plan, but we are working toward the development of a planning system which will plan educational activities on a term by term and year by year basis for one to five years in the future. While the faculty do have several concerns about the use of information systems at WPI, the sheer volume of information which must be manipulated to monitor performance under the WPI Plan necessitates the use of computer based information systems to plan, manage, and evaluate the effectiveness of the innovation.

MANAGEMENT NEEDS FOR INFORMATION

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This paper discusses the increasing demands on higher education by faculty, students, and state and federal government agencies in a time of diminishing resources and increasing complexities. An information system to support decision makers in this environment is also discussed.

OPERATION OF A PRIVATE COORDINATING BOARD

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Board of Higher Education
General Conference of Seventh-day Adventists
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State coordinating boards are well known in higher education. Private coordinating boards have not been as prominent. An example of a coordinating board which has unified a group of independent colleges and universities is the Seventh-day Adventist Board of Higher Education, created in 1970-71 to coordinate the church's twelve North American institutions. One of the most important factors in the unification was the immediate launching of a management information system. Plans were comprehensive, though the system was developed unit by unit over a period, and is still being added to, modified and improved. The computerized information system now includes academic and financial programs, discipline summaries, enrollment analysis, and master file. There is also a uniform masterplanning guide, and the colleges and universities are in various stages in the preparation of their first really extensive master plans, which will then be used as the basis for a system master plan. Comparative data provided by the information system has proved invaluable to the Board in improving efficiency and fostering cooperation among the schools. As the schools have become educated to the possible uses of the reports, the information system is also being used more by administrators in internal management.

EFFICIENCY, EFFECTIVENESS, AND MANAGEMENT INFORMATION SYSTEMS IN HIGHER EDUCATION

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This paper focuses on the definition and differentiation of the two terms "efficiency" and "effectiveness." Efficiency is said to be primarily concerned with cost minimization concepts. Effectiveness, on the other hand, is presented as a goal achievement type of concept. The importance of this distinction to institutions of higher education is discussed and differentiated from that of the more traditionally profit oriented types of organization.

Next, the relationship of Management Information Systems to the decision-making process in institutions of higher education is discussed. Finally, a recent paper by A. W. Astin on the use of student outcome data in Information Systems is discussed as an example of providing input for effectiveness in the decision making process. It is concluded that the use of management information systems in higher education must include student outcome data related to effectiveness criteria as well as to traditional efficiency criteria.

DEVELOPMENT OF ADMINISTRATIVE INFORMATION SYSTEMS

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The early attempts to develop administrative systems are discussed, including unique problems of geographic and technological isolation, recruiting difficulties, and managerial discontinuity. Information service previously considered sufficient, is currently recognized as totally inadequate by a rapidly maturing Saudi Administration. A plan is described that will move the University from a primitive, fragmented environment to sophisticated integrated systems including modeling for University planning and data base management systems for personnel, financial and student records applications.

Wachovia

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STUDENT LOAN SYSTEM AND SERVICE

Roy L. Cooke
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Director of Marketing

Wachovia Services, Inc.
Winston-Salem, North Carolina

Wachovia Services, Inc., the data processing subsidiary of the Wachovia Corporation, presented an overview of their student loan billing system. The system, a product of ten years involvement in student loan processing, is currently serving over 500 colleges and universities. This session provided a detailed insight into the system and the service offered by Wachovia Services.

For further information on Wachovia Services contact the authors at (919) 748-5608 or write to the address above.

PAYROLL/PERSONNEL SYSTEM
FOR
INSTITUTIONS OF HIGHER EDUCATION

The ISI Payroll/Personnel System is a modular information system designed to accommodate and support the special, and often complex administrative requirements of colleges and universities. The system components (or modules) include:

- Payroll Processing and Reporting
- Benefits Administration
- Position Control
- Personnel Records and Reporting

All of the components, and the administrative offices which they serve, are supported by a flexible, expandable Employee Data Base and a modern report generation facility for meeting immediate and one-time report requirements.

The modular design permits independent implementation of system functions; for example, Personnel Records and Reporting may be implemented as a stand-alone system separate from an institution's payroll process. The components are integrated, however, if an information system with broader management capabilities is desired. Whichever components are selected for implementation, the results are significant improvements in clerical efficiencies, employee communications, management reporting, and fiscal controls.

Integral Systems, Inc.

35 Quail Court
Walnut Creek, California 94596

(415) 938-7600

8 Main Street
Flemington, New Jersey 08822

(201) 782-3600

SYSTEMS & COMPUTER TECHNOLOGY CORPORATION
SEVEN NORTH FIVE POINT ROAD ■ WEST CHESTER, PENNSYLVANIA 19380 ■ 215-692-7990

THE SHARED COMPUTER FACILITY:
A CASE HISTORY

John Baillis
General Manager
Software Development
Systems & Computer Technology

Harold Mohamed
Executive Director
Cooperative Computer Center
Illinois Board of Governors

This presentation described the environment in which three sister universities found themselves several years ago, the decisions they made to solve their computing problems, and the results (to date) of those decisions.

For further information on this presentation contact Systems and Computer Technology at the address above.

International Business Machines Corporation

10401 Fernwood Road
Bethesda, Maryland 20034
301/897-2000

IBM SEMINAR

Joseph F. Movizzo
Educational Industry Marketing

IBM Presents: ADVANCED, NEW NETWORKING CAPABILITIES:

- Computer Systems Networking Job Interfaces
- Interactive Terminal Multisystem Networking

Multiple new IBM software products for networking were announced in the period November 9-15, 1976. These new tools are:

BATCH JOB NETWORKING:
- NJE for JES2 Releases 1, 2 & 3
- NJI for VM, HASP & ASP
- JES3 SNA RJP

ADVANCED COMMUNICATIONS FUNCTION - SNA:
- ACF/VTAM & ACF/TCAM
- ACF/NCP/VS
- SSP-System Support Programs
- NOSP-Network Operations Support Program
- TCS-ACF

The Network Job Entry (NJE) Facility for JES2, a program product, offers a significant new function to MVS installations. It supports transmission of selected jobs and in-stream data sets, system output data sets, system operator commands and messages, and accounting information from one JES2 MVS computing system to another across a communications link.

A job entry network consists of a number of computer systems, called nodes, which can communicate with one another to pass job information from one node to the next. The number of nodes within a job entry network ranges from 1 to 99.

Each node can be a single CPU (UP/AP), tightly coupled multiprocessing CPUs, or multi-access spool systems running with NJE for JES2. If a node contains more than one CPU, the connections to the job entry can be made to any CPU or combination of CPUs in the node.

The Network Job Entry Facility for JES2 allows the customer to define a configuration of computer systems that are either in immediate proximity to one another or that are separated by great distances and connected by common-carrier links. Using NJE, computer users can submit their work through any of the computer systems and direct their jobs to the systems which meet the requirements for the work being submitted. Such requirements include:

- Required Data Sets. A job may be directed to the computer system which has access to the data sets needed to run the job.
- Special Hardware Features. A job may be directed to a computer system which has specific hardware features required to run the job.
- Special Configurations. A job may be directed to a computer system which has a specific configuration required to run the job.
- Application Program. A job may be directed to a computer system which runs the particular programs to be used by the job.

- Load Leveling. Jobs which do not have particular requirements for data sets, special hardware features, special configurations, or particular application programs can be directed to the system which has the shortest work queue.
- SYSOUT Destination. A system output data set may be directed to one or more locations in the job entry network.

The 3790 as an RJE terminal is supported through VTAM by NJE Release 2.

Release 3 of NJE for JES2 allows job entry nodes to communicate directly with each other through ACF/VTAM with the Multisystem Networking Facility and ACF/NCP/VS.

The Network Job Interface Programming RPQ's (PRPQ's) transmit card and/or print image data between any combination of systems running HASP II Version 4.0 VM/370 Release 3, PLC 3 and above, and ASP Version 3.2.1. These PRPQ's enable jobs and/or data to be transferred over binary synchronous telecommunications facilities or channel-to-channel adapters. NJI communcates with the Network Job Entry Facility for JES2 program product using compatible protocols (binary synchronous only).

Advanced Communcations Function for VTAM (ACF/VTAM) is a program product for users of DOS/VS, OS/VS1 and OS/VS2 (SVS and MVS) that can provide new capabilities for data communication in a network with a single System/370 or with multiple System/370s.

The ACF/VTAM Multisystem Networking Facility supports cross-system message routing, through which data may be transmitted across systems to its destination without host intervention after initial session establishment by the user terminal.

The ACF/VTAM Multisystem Networking Facility can support cross-system communication for the following types of configurations:

- Multiple System/370 configurations, operating with any combination of DOS/VS or OS/VS operating systems, where each host processor has a network controlled by ACF/VTAM with the Multi-system Networking Facility and ACF/NCP/VS. Optionally, some of the host processors may have networks controlled by ACF/TCAM with the Multisystem Networking Facility and ACF/NCP/VS.
- A network controlled by a single System/370 with two access methods, ACF/VTAM and ACF/TCAM, each with its own Multisystem Networking Facility, in conjunction with ACF/NCP/VS.
- Combinations of the above types of configurations.

The ACF/VTAM Multisystem Networking Facility, in conjunction with ACF/NCP/VS, enables the user to have cross-system communications providing resource sharing, distributed processing, and increased resource availability through the facilities.

For further information, please contact IBM Corporation at the address above.

An Easy Path to Data Base Management

by
Richard B. Bagby
Senior Vice President - Information Associates, Inc.

This presentation described steps taken by Information Associates, Inc., (IAI) in the design of their software systems which have made the implementation of these systems, using a data base management system (DBMS) an economical and easily accomplished task.

Prior to the development of the most common DBMS that are available today (e.g., Total, IMS, System 2000, Etabase, DMS, etc.), IAI had many of the same problems of a college or university administrative data processing center. IAI needed software that was:

- Not hardware dependent
- Easy to maintain and enhance
- Modular in form --
  - For maintenance
  - For installation ease
  - To stand alone or to be part of a larger system
- Economical of machine resources

In addition IAI needed hierarchical data structures for some systems such as Payroll/Personnel and Student Records.

Early steps to improve the quality and flexibility of the programs were ultimately very helpful in providing an easy way to implement and integrate the systems with a DBMS.

One of our first steps was to remove all of the statements relating to the reading and writing of magnetic data from the functional programs and to perform this physical read/write function in an I/O handler that was "CALL"ed by the functional program.

This isolation of functional logic from the input and output of data served two major functions:

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PANSOPHIC

723

THE TERMINAL MAN: RIGHT OR WRONG?

Robert Briggs
Vice President
Pansophic Systems, Inc.

Mr. Briggs discussed on-line programming and programmer productivity with emphasis on Pansophic's newest product, PANVALET/ON-LINE.

For futher information please contact PANSOPHIC at the address listed below.

PANSOPHIC SYSTEMS INCORPORATED • 709 ENTERPRISE DRIVE • OAKBROOK ILLINOIS 60521 • 312 986-6000 amdahl

AMDAHL CORPORATION
2021 SPRING ROAD
SUITE 245
OAK BROOK, ILLINOIS 60521

PHONE 312-887-8590

AMDAHL: THE COMPANY AND THE COMPUTER SYSTEM

Kim C. Kelley
District Marketing Manager

This presentation discussed the background of the Amdahl Corporation, the current computer hardware and software technology, site support, and other aspects of this new computer company and its product.

For further information on AMDAHL CORPORATION contact Kim C. Kelley at (312) 887-8590 or write to the address above.

informatics inc

21050 Vanowen Street
Canoga Park, California 91304
(213) 887-9121 Telex 69-8473
Cable INFORMAT

INFORMATICS: FULFILLING THE COMPUTER'S PROMISE

Informatics Inc. is the recognized industry leader of independently developed software products and services. The capabilities of the Corporation and its people are totally dedicated to "fulfilling the computer's promise" Worldwide satisfaction of its customers' diverse requirements is achieved by the Informatics operating structure composed of multi-faceted autonomous units, specializing in the following areas of software expertise:

Software Products: A group composed of...

... Implementation Systems (MARK IV, CL*IV, SCORE, SHRINK) that provide tools and procedures to increase people/machine productivity.

... Application Products (MARK IV/Auditor, MARK IV/EEO, ACCOUNTING IV, Production IV, Corporate Shareholder System) which are ready-to-use, modular software systems for specific application requirements that eliminate internal development costs and produce immediate results.

... Teleprocessing Monitors (INTERCOMM, BETACOMM, MINICOMM) that provide full transaction control and processing for simple on-line systems up to total communication and task scheduling for large computer networks.

Data Services and Communications Systems: A nationwide computer network offering a broad spectrum of business information handling applications and on-line access to many major data bases covering such subjects as population growth, litigation management, labor arbitration, medical and drug data, cancer research data and environmental protection information.

Support Services: A comprehensive range of custom support and contract-programming capabilities that range from management consulting to turn key installation of major systems. Developing MARK IV-based applications, as well as custom systems written in any programming language, are part of the support capabilities offered.

One of the key products of Informatics is the MARK IV System, which is without question the most successful software product of its kind. Within the college and university communities, MARK IV is an extremely well accepted and highly regarded software tool which increases the productivity and ROI of all people/machine resources. More than 100 educational institutions can attest to the superior, unparalleled benefits of MARK IV.

For additional information pertaining to Informatics and/or any of its products or services, please contact your local Informatics office, or call or write to:

Mr. John F. Bentivegna
Product Manager

software ag
OF NORTH AMERICA, INC

ADABAS—the Adaptable DAta BAse System—is an efficient, flexible and powerful generalized data base management system (DBMS).

ADABAS provides host and query language facilities, report generator capability, data-program independence, complete data protection and data security, concurrent online and batch processing, and operating system and teleprocessing system compatibility.

ADABAS permits the creation of complex hierarchic and network structures without extensive redesign or reprogramming of existing systems and requires minimal training.

ADABAS data compression, inverted file design, and sophisticated buffer management make it the most effective DBMS to install and operate.

For further information please contact Software AG at the address listed below.

11800 Sunrise Valley Drive · Reston, Virginia 22091 · (703) 620-9577, Telex 89-9122

Cincom Systems, Inc.
2300 Montana Avenue, Cincinnati, Ohio 45211 Tel. 513 662 2300 TWX 810 461 2732

THE EVOLUTION AND FUTURE OF DATA BASES
A MANAGEMENT PERSPECTIVE

Matt Peterson
Manager
Marketing Administration
CINCOM Systems, Inc.

The discussion in this special session was centered around the evolutionary second and third generation file management and data base management system (DBMS) approaches. These approaches provided a foundation for further discussion of advanced approaches and concepts and their impact in the future.

For further information please contact CINCOM Systems, Inc. at the address above.

SPECIAL INTEREST GROUPS

Tuesday afternoon before the Conference the following Special Interest Groups met. These meetings provided an opportunity for individuals with interests in specific areas of higher education management information systems to share their experiences. The Special Interest Groups were convened by the persons listed below.

CICS   Robert Stearns, University of Georgia

IMS and Data Dictionary   William McKelvey, Ohio State University
Janet Wixson, University of Alabama, Birmingham

MARK IV   Dorothy Hopkin, University of Illinois

NCHEMS Computer Products   Jerry Brown, Rider College
Michael Mullen, Va Council of Higher Education

Small College Information Systems   William Shoemaker, Council for the Advancement of Small Colleges

SYSTEM 2000   Martha Fields, State University System of Florida

TOTAL/ENVIRON1   Robert Schaulis, Coast Community College
Robert Ogilvie, American University